GAS JOURNAL, MAY 25, 1938

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Editorial Notes

West Yorkshire Gas Grid

THE Bill dealing with the distribution of coke oven gas in a large area of West Yorkshire, promoted by the West Yorkshire Gas Distribution Company, with the backing of the United Kingdom Gas Corporation, has been before a House of Lords Committee presided over by Lord Cozens-Hardy. A report of the proceedings before that Committee was published in last week's "JOURNAL." As the Bill has to pass through the usual stages in the House of Commons we have no wish to indulge in critical comment on it. On the other hand it may help if we draw attention to what we consider were the high lights during the Committee's hearing and to the Committee's finding.

The objects of the Bill were to incorporate the Company with an authorized capital of £750,000 with borrowing powers equal to half that amount, and to empower it to make contracts with coke oven undertakings for the purchase of coke oven gas and with gas undertakings for the sale of this gas. It was proposed to lay mains in a wide area at present served by 61 gas undertakings, 19 of which are under the control of the United Kingdom Gas Corporation—in other words, to construct a gas grid. Gas undertakings were to be free to accept or to refuse a supply from the grid; equally the Company was to be under no obligation to supply gas. In brief, the Company was prepared to shoulder the risk of laying the main, in the belief that it would be able to sell gas at prices low enough to attract a vast volume of industrial business in an area in which the potential demand for such a supply is very great. The basis of the Bill, then, was voluntary.

As to the potential demand, Colonel W. M. Carr stated in evidence that in the areas supplied by the companies controlled by the United Kingdom Gas Corporation enquiries already made showed, at the low price which he visualized for gas, a demand for 1,610 million cu.ft. per annum. Estimates indicated that a load of 4,124 million cu.ft. could be secured within a reasonable period if gas were available at a minimum price of 3d. a therm. In regard to supply he mentioned that in one instance the U.K. Corporation had become financially interested, to the extent of 40%, in the erection of new coke ovens. The right to take gas at 7½d. per 1,000 cu.ft. from these ovens was to be transferred to the West Yorkshire Gas Distribution Company, and the contract would extend over 25 years.

The Bill was very strongly opposed. Among the grounds of objection were that the new Company would compete with the existing gas undertakings in obtaining supplies of coke oven gas, that it would obtain a monopoly in the purchase of gas, that it would be an unnecessary middleman. It was also argued for the opposition that the more successful the grid, the greater would be the output of coke in competition with that produced by the gas undertakings, so that coke prices would be depressed; a process of economic pressure would compel the gas undertakings to buy gas from the grid at such prices as the promoters could get out of them.

For the promoters Counsel argued that if, as a result of the proposals in the Bill, gas could be sold more cheaply, there would be a greater demand for it, and whether the gas was made at the coke ovens or at the gas-works, the effect was the same in regard to the output of coke. If the promoters bought coke oven gas which otherwise would be wasted, then they would be improving the demand for gas without increasing the supply of coke. In regard to continuity of supply in the event of failure at the coke ovens, it was suggested during the hearing that the grid scheme would enable stand-by plant to be dispensed with at practically all the gas-works connected to the grid. There would, said Mr. Edward Crowther, Chief Engineer to the U.K. Corporation, in evidence, be a linking up of gas undertakings both to each other and to suppliers of coke oven gas, and he visualized receiving gas not only from coke ovens but also in certain cases from gas undertakings which might have efficient surplus plant that could be put into production. That gas-works plant represented a valuable element of safeguard.

The availability of surplus coke oven gas in the area was naturally an important subject of discussion. In reply to Lord Cozens-Hardy, Colonel Carr said it was estimated that in the first stage the undertakings controlled by the United Kingdom Gas Corporation would absorb all the available supplies. In the second stage other sources of coke oven gas would be available, and there would be a surplus available for other undertakings. Counsel for the opposition argued that the scheme lacked definition.

The Committee's Finding

As reported in the "JOURNAL" last week, after a very short deliberation by the Committee Lord Cozens-Hardy announced that the Bill could only proceed if it were limited to the areas already controlled by the United Kingdom Gas Corporation, and that if it were necessary for the linking up of the Corporation's undertakings to lay mains through other areas, then separate application would have to be made. The promoters were given power to take coke oven gas from the ovens in which the United Kingdom Gas Corporation is

financially interested at Hemsworth and to lay a main from the ovens to the area controlled by the Corporation.

As we have said, we have no intention of levelling criticisms at the Bill. It does, however, bring to the forefront once again the problem whether it is sound policy for the Gas Industry to be dependent on carbonization at the pithead. It has, we think, been shown conclusively that, all things being equal, it is not cheaper to manufacture gas in coke ovens than in other forms of carbonizing plant. It has also been shown that coal can be transported more cheaply than gas and coke to the point of consumption. Our opinion is that pithead carbonization in this country is advantageous in limited degree only. Future events may prove us to be in the wrong. Who, however, is sufficiently wise or bold enough to foretell the future of carbonization and gas making? The technique of gas making has developed so much theoretically during the past year or two that it needs but slight change of economic balance to transform the dreams of both scientists and business men into realities. It can be argued—and, we think, with justification—that when circumstances warranted, the coke oven interests, which are akin to those of the Gas Industry, could take advantage of this new technique. We query, however, whether the Gas Industry, with the many types of plant at its disposal, with the enormous advantage—we almost said "gift"—of flexibility should tie itself to a particular form of bulk horizontal carbonization. We think we are right in saying that, to date, the huge increases in industrial gas consumption registered by certain undertakings have been the result of buying gas which would otherwise have been blown, or "fired," to waste. The terms of purchase have been good. Are we to assume that these terms are permanent?

Present Trends and Future Developments

THE Address which Mr. R. J. Rogers gave to the Midland Junior Gas Association recently and which was published in last week's "JOURNAL" was thoroughly stimulating. Throughout, Mr. Rogers has, in common with ourselves, actively supported the Junior movement. Of the Midland Juniors he was one of the early members, and is a Past-President and an Honorary Member. In that he is youthful in mind and outlook and gives to new ideas a ready welcome he is a "junior:" and with this interpretation of the word—that one should never be too old to learn—he finds no fault with the appellation of the younger organizations which, from small beginnings, have grown enormously in membership and in the standard of their work and discussions—to an extent, in fact, which has led to objection to "Junior" as applied to these Associations.

Recalling his Presidential Address to the Midland Juniors twenty-seven years ago, Mr. Rogers discussed in the light of over a quarter of a century's progress some of the subjects he then dealt with. They included competition, which has steadily grown. It has been beneficial to both the electricity and the Gas Industry; but many will share his view that certain aspects of uneconomic competition could well be abandoned now; there would remain ample scope for healthy rivalry between the two industries. Then there was the question of education in the Gas Industry. In 1911 Mr. Rogers advocated a national scheme for the training of gas fitters. This scheme came into being, and for some years he acted as Chief Examiner in Gas Fitting. How often we have urged that money expended in the training of gas fitters is money well spent, that the service rendered by the Industry to the consuming public cannot be first-class unless the men who have to install and maintain appliances in consumers' premises are fully trained. The experience of Mr. Rogers both on the supply side of the Industry and as a manufacturer of appliances has left him in no doubt as to the value, the necessity, of adequate training and thorough working knowledge of new developments.

Research was another of the subjects dealt with by Mr. Rogers in his Presidential Address in 1911. Since that time our Industry has awakened to the fact that research of all kinds must constitute the basis of progress, and that this research to be fully effective demands co-operation between buyer and seller of equipment for making and using gas and between both and the universities and research associations. In this regard Mr. Rogers spoke of the work the Society of British Gas Industries is carrying out for the advancement of the Industry—a matter which was the subject of comment in these columns last week. The need for a greater measure of standardization of gas-consuming appliances, the value of the street lighting load, the desirability of reducing to a minimum the sulphur compounds in town gas, and the possibilities of the water heating and central heating loads for gas were among the topics touched upon by Mr. Rogers. One of the most prolific fields for the development of new consumption is that of providing hot water for all domestic purposes and for central heating boilers, "but," said Mr. Rogers—and we would emphasize this—"it is necessary that every gas undertaking should have suitably trained personnel to ensure that gas consumers receive the correct advice and the most suitable type of apparatus to meet the particular requirements of each household." The manufacturers have played their part by placing on the market a wide variety of types of efficient gas water heater certain to give good service on the district if they are correctly installed and properly maintained. The development of the load, however, will largely depend on the tariffs framed by gas undertakings. We are glad that Mr. Rogers should call attention to this urgent line of policy. Granted such attractive tariffs he shares our view that it will be economically possible for the householder to use gas universally in the home for heating, cooking, and the provision of hot water.

South-Eastern Gas Corporation

ON later pages will be found a report of the sixth Annual Meeting of the South-Eastern Gas Corporation, and in his speech Sir David Milne-Watson was able to refer to the good progress effected during the past year. Two more companies, the North Middlesex and the Windsor undertakings, have been acquired; and as the areas of these undertakings adjoin the area of the Gas Light and Coke Company, the acquisitions are in accord with the principle of grouping on a geographical basis, which, of course, allows the fullest benefits to be secured from holding company control. Sir David spoke of some of the economies and advantages obtained by the purchase of stores in bulk, by co-operation in sales policy, by the planning of extensions to works and mains with a view to future developments. Uniformity has been made possible in conditions of sale of appliances over an area of more than 900 square miles. There is no need for us to emphasize the healthy effect of this policy of uniformity and the weight given to sales campaigns by co-operative planning. The number of administrative units of the Corporation is at

present 26, but Sir David, while pointing to the advantages of a system of control whereby the undertakings taken over retain their individuality, expressed the view that some reduction in the number of units would be of undoubted benefit.

An average increase in gas sales of 2·8% was secured during the year; several public lighting contracts, the period of contract being in some instances as long as 15 years, have been obtained; sales of appliances in many cases constituted a record. New showrooms have been built, and benzole plants have been installed at a number of the works of the controlled undertakings. Actually the output of benzole for the past year was 75% greater than that for the preceding year. Already a number of promotional tariffs for gas have been introduced, and "more will be introduced as soon as possible, so that gas may be obtained for all purposes at reasonable rates."

The speech of Sir David was a most encouraging one, though he had to refer regretfully to the heavy increase in costs of production due largely to the big increases in the cost of coal as a result of the monopolistic selling schemes. Higher coal prices, as Sir David emphasized, impose an additional handicap on the Gas Industry in that raw coal is a direct competitor of gas in the domestic and other fuel markets. "It is a point of serious public concern," he said, "that the lessening of the smoke menace which costs this country so dear in health, in money, and in amenity should not be slowed down or interrupted because the smoke-producing fuel has the power to hold to ransom the two great industries whose business it is to take raw coal and turn it into cleaner and more efficient forms of heat and energy." We have had a good deal to say recently on this question of smoke abatement, and have suggested that on the whole the Gas Industry is not supporting this worth-while movement to benefit the health of the nation and to cut down waste. It is surprising that so much apathy is to be discerned in helping the cause. The smoke evil need not exist, for the Gas Industry can show that the public need not suffer financial hardship, but on the contrary can actually save money, by using gas and coke in place of raw coal.

Advertising Gas Cooking

It is common knowledge that the efforts of the electricity industry to increase its cooking load have been redoubled in recent times, and every branch of the forces at its disposal has been brought to bear in the general assault upon a position which is so widely—and strongly we would say—held by gas. In their general propaganda the organizers of the campaign have made sweeping statements which we of the Gas Industry know to be unjustified by the facts, but claims made—or even hinted at—in well-written advertising copy are difficult to counter and, if they once get a start, are liable to do damage before they are overtaken.

In this connexion we believe the Gas Industry will have noted with very considerable satisfaction a recent change in the national advertising policy of Radiation Ltd. Over a period of fifteen years or so, by means of well judged and widespread advertising in the Press and elsewhere, Radiation have built up an enormous goodwill for their own particular cookers, but no one can deny that their policy has been most open-handed in the matter, and that the good cause of gas cooking in general has benefited by their large expenditure devoted to stressing its merits. It has always been a principle of their propaganda, however, to concentrate upon stressing these merits rather than decry the electrical rival—a principle of which there can be nothing but approval. At the same time we are pleased to notice in their latest announcements that, while fully maintaining the dignity which we would all wish to see continued, they show a very well-defined acceptance of the electrical challenge. For example, ease and exactness of heat control are stressed without "making shift with just two or three fixed heat levels" none of which may be exactly right for the discerning cook, and emphasis is, of course, laid upon the availability of speed when speed is an essential.

Our readers will not fail to notice in these two points alone a direct reply on matters upon which there has been misrepresentation from the rival camp. This has unfortunately in a few cases, often assisted by other unfair influences of which we are all aware, achieved inroads into the cooking load. The Gas Industry, even if it would not wish to see Radiation advertising adopt a completely "gloves-off" attitude, will welcome the more vigorous tone which has lately begun to characterize it. We can gain nothing by refusing to recognize the challenge of the electricity campaign, especially when it is directed towards a section of the public which is not in a position to "try everything once" before finally deciding that if you don't want to be "handcuffed to your cooker, only Mr. Therm's flexible flame will set you free."

B.S. Specifications for Tarmacadam

In the "Journal" to-day announcement is made of the Publication by the British Standards Institution of Specifications for Tarmacadam, one covering granite, limestone, and slag aggregate, the other dealing with the surfacing of roads with tarmacadam. The specifications have been based on proposals originally prepared by the British Road Tar Association, and in their task they received the close co-operation of the national organizations representing the roadstone and slag industries, the County Surveyors' Society, the Institution of Municipal and County Engineers, the Ministry of Transport, and the Road Research Laboratory. The adoption of the first standard specifications for tarmacadam surfacing by the British Standards Institution is an event of importance not only to the tarmacadam and road tar industries but to all to whom the construction and maintenance of roads are entrusted.

Training in Illuminating Engineering

The City and Guilds Institute has initiated a Syllabus of Examinations in Illuminating Engineering and the award of National Certificates. This new move, which is to be welcomed, was considered by Dr. J. W. Whitaker, of the Huddersfield Technical College, in a recent Paper to the Association of Technical Institutions. He explained that a young student aiming at the profession of illuminating engineering should first obtain the standard of education involved in an Ordinary Grade Certificate in Gas or Electrical Engineering. The new scheme is the result of collaboration between the Illuminating Engineering Society, the Association of Public Lighting Engineers, and other bodies, and the City and Guilds of London Institute; and it is proposed to hold the examination in two grades, Intermediate and Final, the former being compulsory. For the Intermediate examination a course of two or three evenings per week, extending over two years, will probably prove necessary to cover the lighting and ancillary subjects. Dr. Whitaker pointed out that openings for qualified research workers are fairly numerous and that there are many opportunities in the services of the leading firms in the lighting industry. The number of openings for public lighting engineers continues to grow. The lighting of only moderately large towns involves an annual expenditure of some £100,000, and such work requires supervision by properly qualified illuminating engineers. We feel that this "hallmark" of Certification is a step in the right direction.

Personal

New Livesey Professor.

The Council of the University of Leeds has elected Mr. D. T. A. TOWNEND, D.Sc. (London), to the Livesey Chair of Coal Gas and Fuel Industries, to take office from October next, in succession to Professor J. W. Cobb.

After nearly four years of war service, Professor Townend entered the East London (now the Queen Mary) College of London University. He graduated in 1920, and then proceeded to the Department of Chemical Technology at the Imperial College of Science, London, for post-graduate study and research under Professor W. A. Bone. He has since collaborated with Professor Bone more particularly in investigating gaseous explosions at high initial pressures. Professor Townend was awarded successively a Salters' Research Fellowship and a Rockefeller International Research Fellowship. He has been largely concerned in the equipment and organization of the High Pressure Laboratories at the Imperial College. Professor Townend, who is a Recognized Teacher of London University, is an authority on combustion and high pressure problems, and has published many books and articles both independently and in collaboration with his colleagues at South Kensington.

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The employees at Tranent and Prestonpans have presented Mr. W. P. GILCHRIST, Tranent, with a gold-mounted fountain-pen on his leaving to take up the position of Manager at West Wemyss. The presentation was made by Mr. David Ostler, and ex-Provost A. McDonald, Engineer and Manager at Prestonpans and Tranent, also paid a tribute to Mr. Gilchrist's valued services.

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Mr. R. S. SNELLING, who has been Assistant Secretary of Newport (Mon.) Gas Company since 1931, has been appointed Secretary, in succession to the late Mr. William Stanford. He has seen thirty-one years' service with the Company, with whom he started as a junior clerk. Mr. Snelling was for five years Secretary of the Wales and Monmouthshire Junior Gas Association, resigning the office in 1937. The new Secretary is a Fellow of the Chartered Institute of Secretaries, and a member of the Council of South Wales and Monmouthshire Branch. He is also a member of the Executive Committee of the Newport Chamber of Trade.

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Messrs. George Wilson Gas Meters, Ltd., announce the appointment of Mr. G. ORMEROD to the position of their Yorkshire Branch Managership. Mr. Ormerod is, of course, already well known to many Gas Engineers, since he has been one of the firm's most popular members for the past ten years. It may be recalled by some that, in his capacity as Technical Engineer in 1932, it was his signature at the bottom of the letter which announced the advent of the straight-line valve system to the Gas Industry. For the past few years he has been most actively engaged in various experiments the results of which the firm hope to divulge in the near future. Mr. Ormerod is, therefore, a most fitting person for the position, since he has a vast fund of technical knowledge at his disposal.

Obituary

It is with regret that we announce the death, on May 20, of Mr. W. J. FRIENDSHIP, Secretary of the Dartmouth Gas, Coke, and Coal Company. He had been with the Company for thirty years.

The Sheffield Gas Bill

On pages 621-25 of our issue to-day will be found a report of the hearing on Monday and Tuesday of last week, by a House of Lords Committee, of the Sheffield Gas Company's Bill. Pressure on our space makes it necessary to hold over till next week our report of the proceedings on the Wednesday, when the hearing was concluded.

At the end of the Company's case, without calling upon the opposition, the Committee announced its finding that the preamble of the Bill had not been proved.

In reply to the Chairman (Lord Cozens-Hardy),

Sir WALTER MONCKTON, K.C., said that the Company wished to proceed with the provisions of the Bill providing for the change of name to "The Sheffield and District Gas Company," and for the consolidation and simplification of the existing provisions of the Company's Acts and Orders relating to its depreciation fund.

There was no opposition to these two provisions.

Amalgamation and Grouping

Tottenham and St. Margarets.

The Tottenham and District Gas Company have taken over control of the St. Margarets (Herts) Gas Company. At the same time there will be a reduction in the price of gas in that area, and an introduction of a tariff, which will enable St. Margarets and District to gain even further benefits by the increased use of gas. Tottenham and District Gas Company have taken immediate steps to obviate any shortcomings in the distribution system, relaying certain sections of the mains to ensure an ample supply of gas at full pressure to all parts.

Sectional Meeting of the World Power Conference

The general "terms of reference" for the Sectional Meeting of the World Power Conference to be held at Vienna from Aug. 25 to Sept. 2 this year (with a week of "Conference Journeys" to follow) are stated in brief as "The Supply of Energy to Agriculture, Small-scale Industries, Household Purposes, Public Lighting, and Electrical Railways." Out of more than 200 Papers to be presented, thirteen are from this country, and the interests of the Gas Industry are well supported.

Mr. W. J. G. Davey and Mr. A. R. McGibbon, members of the Joint Lighting Committee of The Institution of Gas Engineers and the Society of British Gas Industries, have collaborated in a Paper on "Public Lighting by Gas" to be delivered, or rather presented, on Friday, Aug. 26. Under the title "Gas for Small-scale Industries" Mr. W. Dieterichs, of the Gas Light and Coke Company, presents a Paper on Monday, Aug. 29; and "Gas for Household Purposes" is in the hands of Mr. W. J. Sandeman, Chairman of the Executive Committee of the British Commercial Gas Association, down for either the Wednesday or Thursday of the same week. The Papers will be summarized in the usual way in a general report, having been circulated beforehand, their chief points being given, and will be published in due course with the report of the discussion in the Transactions of the World Power Conference.

Among the visits arranged is one on Friday afternoon, Sept. 2, to the Vienna Gas-Works.

Another Paper of interest to gas engineers is to be given by Mr. H. L. Pirie, Chief Engineer to the Coal Utilisation Council, entitled "The Supply and Use of Solid Fuels for Domestic Purposes in Great Britain."

The Vienna Conference Committee, and the British National Committee, of which Sir Harold Hartley is Chairman, have authorized Messrs. Thos. Cook & Son to act as Travel Agents for the Meeting. The Committees on both sides have worked in the closest co-operation, and the result is that participation in the Vienna Meeting will be simplified very satisfactorily for British travellers in every way. Payment may be made in English money if desired, and the charges for the fortnight are most reasonable. Full details of the programme, accommodation, cost, &c., can be obtained from the Secretary, British National Committee, World Power Conference, 36, Kingsway, London, W.C. 2, and early application is desirable from those intending to take part.

Forthcoming Engagements

May.

26.—Midland Association.—Spring Meeting at Walsall.

31.—June 1, 2, and 3.—I.G.E.—75th Annual General Meeting.

June

16.—S.B.G.I.—Council Meeting, 11.15 a.m.

17.—I.G.E.—Refractory Materials Joint Committee, Mellor Laboratories, Shelton, Stoke-on-Trent, 2.30 p.m. (*Altered from June 16.*)

18.—Western Juniors.—Summer Meeting at Dartmouth.

23.—B.G.F.—Visit to Empire Exhibition, Glasgow.

24.—Southern Association.—Summer Meeting at Lea Bridge.

25.—London and Southern Juniors.—Summer Visit to Folkestone.

30.—Southern Association (Eastern District).—County Meeting at Croydon.

[*No meeting of the Central Executive Board of the National Gas Council will be held in June.*]

July.

22.—I.G.E.—Joint Research Committee, 2.30 p.m. (*Transferred from June 24.*)

24.—I.G.E.—Liquor Effluents and Ammonia Committee, 11.15 a.m. (*Transferred from June 24.*)

Annual Meeting of THE INSTITUTION OF GAS ENGINEERS

May 31 to June 3

1938

The 75th Annual General Meeting of The Institution of Gas Engineers will be held at The Institution of Civil Engineers, Great George Street, London, S.W. 1, from May 31 to June 3 next, under the Presidency of HAROLD C. SMITH (Chief Engineer to the Tottenham and District Gas Company). We publish on the following page full details of the programme.

THE PRESIDENT

A Promising Programme

THE arrangements which have been made for the Annual General Meeting of The Institution of Gas Engineers, which will be held in London next week under the Presidency of Mr. H. C. Smith, should ensure another successful conference. There are to be six Papers dealing with subjects covering a wide range of interest from the general to the specific. To-day, in our First Institution Number, we publish three of these Communications *in extenso* and the remaining three only slightly abridged.

The first Communication to be presented on Tuesday morning is by Mr. E. V. Evans, who remarks in an introduction that, in explaining to members of the Institution, as Chairman of their Research Executive Committee, some considerations which are influencing the course of its development work, he temporarily divorces himself from his position as an official of a gas undertaking. We have, of course, at this stage no intention of commenting on the Papers, but this contribution, which is in the best Evans style, should evoke a most interesting discussion. The subject appeals to us as one singularly appropriate as the first to be brought under purview at the meeting. The other Paper on Tuesday is by Mr. F. B. Richards—the first Communication to be presented by a Corporate Member of the Institution who comes from the contracting side of the Gas Industry, and a welcome indication of the broadened vision of the Institution. In this Paper, carbonization is viewed through the eyes of a plant designer.

On Wednesday morning we temporarily leave gas-making to discuss a Paper on "Coke and its Scientific Uses," by Dr. F. J. Eaton, and one on "Cast Iron Research and the Gas Industry," by Mr. J. G. Pearce. The former is concerned with the utilization of coke for space heating in the open fire, for automatic firing in central heating and hot water supply boilers, and for industrial drying processes in the semi-producer furnace. The Paper by Mr. Pearce reviews the developments which have resulted from organized research on cast iron in so far as they interest the gas engineer, and it includes observations on various investigations which might profitably be undertaken by the Gas Industry in collaboration with the British Cast Iron Research Association. Then, as far as the business sessions are concerned, we adjourn till Thursday morning, when the meeting will be resumed with a Paper by Mr. W. J. Sandeman outlining the methods adopted by the Croydon Gas Company to deal with distribution and sales. The Company has, of course, a high and well-earned reputation for efficient organization on these two important sides of the Gas Industry. The final Paper is for the works engineer. Fittingly it is by the Works Engineer, Mr. W. Hawkyard, of the President's Company, and it describes the methods of control practised at the Willoughby Lane Gas-Works.

An outstanding feature of the meeting, and one which will give pleasure not only to members of the Institution, will be the presentation to Sir David Milne-Watson of the Birmingham Medal, which was endowed by subscription in 1881. Since then only 13 awards have been made, which shows the jealous care of the Institution in its bestowal. Among the names which figure on the list are to be found Sir George Livesey, Thomas Newbigging, Baron von Welsbach, Sir Corbet Woodall, and Dr. Charles Carpenter. The Medal is one of the greatest distinctions which the Institution can confer and is only awarded as a mark of special recognition of outstanding service rendered to the Industry over a number of years. The name of Sir David Milne-Watson will add

lustre to the list of eminent men to whom the Medal has been awarded.

Turning from business to pleasure, let us take a glance at the social events and visits which have been arranged. The President's reception is on Tuesday evening, and, as previously, at Grosvenor House. On Wednesday afternoon there is the opportunity of visiting the Fuel Research Station—and the growing co-operation between the Fuel Research Board and the Gas Industry will make this visit all the more enjoyable and useful—while a visit to the Port of London has been planned for the ladies. On Thursday afternoon the President's Works at Tottenham, and the Gothic Works of Glover & Main, Ltd., are to be inspected; and the customary tour on the Friday, with this time Southampton as focal point, will provide interest and enjoyment.

Altogether a promising programme. We feel that Dr. Braunholtz will be able to look back with pride on his first Annual General Meeting as Secretary of the Institution.

PROGRAMME OF THE MEETING

TUESDAY, MAY 31.

10. 0 a.m. — Opening of the 75th Annual General Meeting at The Institution of Civil Engineers, Great George Street, London, S.W. 1.
Welcome to Representatives from Overseas.
Adoption of the 75th Annual Report and Accounts. (*Communication No.* 178.)
Scrutineers' Reports of the Ballots.
Presentation of Medals.
Presidential Address by Harold C. Smith, M.Inst.C.E., M.Inst.Gas E., Chief Engineer, Tottenham and District Gas Company. (*Communication No.* 179.)

11. 0 a.m. to 12 noon — Paper on "Considerations upon the Processing of Coal," by E. V. Evans, O.B.E., M.Inst.Gas E., F.I.C., Chairman, Research Executive Committee, The Institution of Gas Engineers. (*Communication No.* 180.)

12.15 p.m. — Photograph of the 75th Annual General Meeting on the Horse Guards Parade, St. James's Park, London, S.W. 1.

12.45 p.m. — President's Luncheon in the Ballroom of the Savoy Hotel, Victoria Embankment, London, W.C. 2.

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3. 0 p.m. — Paper on "Carbonization from a Plant Designer's Viewpoint," by F. B. Richards, M.B.E., M.Inst.C.E., M.I.Mech.E., M.Inst.Gas E., Chairman of the Woodall-Duckham Companies, London. (*Communication No.* 181.)

4. 0 p.m. to 4.30 p.m. — Submission to Corporate Members of proposals for increasing the Revenue of the Institution.

9. 0 p.m. to 2. 0 a.m. — Reception and Dance in the Great Room of Grosvenor House, Park Lane, London, W. 1.

WEDNESDAY, JUNE 1.

10. 0 a.m. — Paper on "Coke and Its Scientific Uses," by F. J. Eaton, Ph.D., B.Sc., A.I.C., Gas Light and Coke Company. (*Communication No.* 182.)

11. 0 a.m. — General Meeting of Contributors to the Benevolent Fund of The Institution of Gas Engineers.

11.15 a.m. to 12.15 p.m. — Paper on "Cast Iron Research and the Gas Industry," by J. G. Pearce, M.Sc., M.I.Mech.E., F.Inst.P., Director and Secretary, The British Cast Iron Research Association. (*Communication No.* 183.)

2.15 p.m. to 6. 0 p.m. — Visit by Motor Coach to the Fuel Research Station, East Greenwich, London, S.E. 10.
Ladies' visit by Motor Launch "Royal Princess" to the Port of London, with tea aboard. Members may participate.

THURSDAY, JUNE 2.

10. 0 a.m. — Paper on "From Holder to Burner," by W. J. Sandeman, M.Inst. Gas E., General Manager, Croydon Gas Company. (*Communication No.* 184.)

11. 0 a.m. — Paper on "Works Control," by W. Hawkyard, M.Inst.Gas E., M.I.Chem.E., Works Engineer, Willoughby Lane Works, Tottenham and District Gas Company. (*Communication No.* 185.)

12 noon to 12.15 p.m. — Concluding Business of Meeting.

12.45 p.m. — Council Luncheon to the President in the River Room of the Savoy Hotel, Victoria Embankment, London, W.C. 2.

(*a*) 2. 0 p.m. to 6. 0 p.m.
(*b*) 2.15 p.m. to 6. 0 p.m. — Visit by Motor Coach to the Willoughby Lane Works of the Tottenham and District Gas Company, and to the Gothic Works of Glover & Main, Ltd., Edmonton:
(*a*) *Via* the Hertford Works of the Tottenham and District Gas Company, or
(*b*) Direct. Ladies may participate.

FRIDAY, JUNE 3.

VISIT TO SOUTHAMPTON.

WATERLOO—SOUTHAMPTON—SOLENT—NEW FOREST (BEAULIEU ABBEY—LYNDHURST)—SOUTHAMPTON—WATERLOO.

Morning: Waterloo (9.19 a.m.) by special train to Southampton Central Station.
Visit by Motor Coach (11 a.m. to 12.30 p.m.) to:
(i) Southampton Gas-Works, or
(ii) Gas Showrooms and Fittings Department of the Southampton Gaslight and Coke Company, or
(iii) S.S. "Empress of Britain."
Luncheon (12.45 p.m. to 2.15 p.m.) at the Guildhall.

Afternoon: Motor Coach (2.20 p.m.) to either:
(i) Southampton Pier for a Cruise on the Solent in M.V. "Medina," with tea aboard, or
(ii) New Forest Tour, including a visit to Beaulieu Abbey, and tea at Lyndhurst,
Returning to Southampton Central Station.

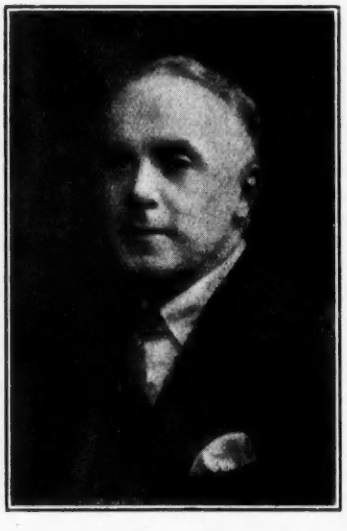
Evening: Southampton Central Station (5.55 p.m.) by special train (on which supper will be served) to Waterloo (7.27 p.m.).

Ladies may participate. The arrangements permit of the issue of tickets omitting the special train journey and/or the visits, cruise, and tour. The railway ticket will entitle the holder to travel on the special train or on any ordinary train to and from Southampton on the Friday. The ticket may be converted to a summer return ticket on payment of a supplement of 4s. 11d. at Southampton Central Station.

THE SENIOR VICE-PRESIDENT.

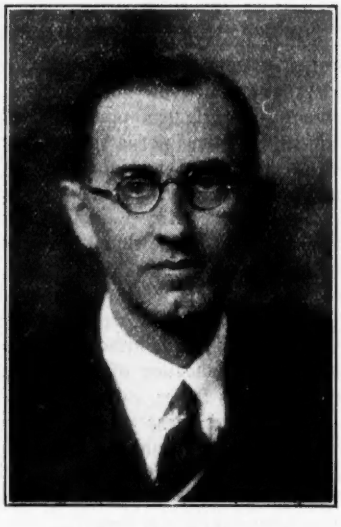
R. Robertson.

THE JUNIOR VICE-PRESIDENT.



G. Dixon.

THE SECRETARY.



W. T. K. Braunholtz.

THE INSTITUTION AUTHORS

With Summaries of their Technical Communications

J. G. PEARCE
Director and Secretary, British Cast Iron Research Association).

Cast Iron Research and the Gas Industry

Communication No. 183

by

J. G. PEARCE, M.Sc., M.I.Mech.E., F.Inst.P.

(Director and Secretary, The British Cast Iron Research Association)

Mr. J. G. Pearce graduated at the University of Birmingham, and took an engineering apprenticeship course at the Metropolitan-Vickers Electrical Co., Ltd., Manchester. Subsequently he was engaged in the establishment of the Company's Research and Education Department. After some months in the United States and in various continental works, he was appointed in 1924 Director of the British Cast Iron Research Association. Since that date the Association has steadily increased in size, and its staff now exceeds forty. Mr. Pearce is a member of the Metallurgy Research Board and the Iron and Steel Industrial Research Council. He was also largely instrumental in the establishment of the British Foundry School, a specialized high school for the training of executives for the foundry industry, which opened in Birmingham in 1935.

During the past fifteen years a considerable amount of organized research has been carried out on cast iron and its methods of production in this and other countries, and the object of this Paper is to review these developments in so far as they should interest the gas engineer and to stimulate the wider application in appropriate situations in the Gas Industry of the varied range of cast irons now available.

The Author surveys the uses of cast iron in connexion with the manufacture of gas and coke, as well as in gas distribution and utilization, and examines the properties of various grades of cast iron, particularly in regard to their mechanical strength and their resistance to heat, corrosion, wear and erosion.

The Paper concludes with some observations on various investigations which might profitably be undertaken by the Gas Industry in collaboration with the British Cast Iron Research Association.

Coke and Its Scientific Uses

by

F. J. EATON, Ph.D., B.Sc., A.I.C.

(The Gas Light and Coke Company)

Dr. F. J. Eaton received his training in chemistry at Heriot-Watt College and Edinburgh University where he studied under Professor Sir James Walker. After receiving his B.Sc. degree in 1921 he carried out post-graduate research under Professor G. Barger, and obtained his Ph.D. degree in 1923. He joined the Gas Light and Coke Company in 1924, and for the last five years has been in charge of the Coke Appliances Section of the Fulham Laboratory.

Communication No. 182

F. J. EATON
(Coke Appliances Section, Gas Light and Coke Company).

This Paper deals with the utilization of coke for space heating in the open fire, for automatic firing in central heating and hot water supply boilers, and for industrial drying processes in the semi-producer furnace. The properties of coke which make it suitable for these markets are reviewed and the design of the appliance in relation to these properties is discussed. Special attention is directed to the preparation and utilization of coke in the domestic market. It is shown that, because of the small fuel capacity of the domestic coke appliance, a freely combustible and closely graded fuel is required. For the production of such a fuel the carbonizing conditions have to be chosen so that the resulting coke is uniform in quality and the formation of the less combustible graphitic carbon is minimized. One method is described by which such a fuel can be produced from either run-of-mine Durham or Yorkshire coals by modern methods of high temperature carbonization.

For central heating and hot water supply the use of

thermostatic control equipment is shown to be of advantage in improving the service obtained from coke. The importance of this aspect of coke utilization and its bearing on the automatic operation of boilers is emphasized and a section on typical modern controls is therefore included.

Throughout the Paper special attention is directed to the importance of the combustion rate in relation to the properties of coke and the purpose for which the appliance is designed. Thus in the case of hot water supply boilers, where the load fluctuates between wide limits, it is desirable to have a combustion rate of about, but not exceeding, 10 lb. per sq.ft. of grate area per hr. This allows sufficient margin from the minimum combustion rate, at which the fuel will just keep alight, to avoid overheating when the demand for hot water is small, while when this is large clinker formation and the need for frequent cleaning of the fire are minimized. With central heating boilers the load conditions are more constant but during cold weather they may operate for long periods at their rated output and for this reason a lower combustion value should be chosen.

A further factor to be considered is the number of hours during which the appliance is required to operate without attention. For hand-fired central heating boilers this is normally 6 hours and the combustion rate chosen should be of the order of 8 lb. per sq.ft. of grate area per hr., while for gravity-feed boilers, where automatic operation for 24 hours is aimed at, this rate should be reduced to about 5 lb. These combustion rates are only approximate, since they refer to average cokes which may be taken to have an ash content of 8 to 10 per cent. and an ash fusion temperature (β point) of 1,150 to 1,250° C. For coke appliances in general, much work remains to be done to determine the influence on combustion rate of the following variables: fuel size, ash content, ash fusibility, chimney draught and the frequency with which it is necessary to clean the fuel bed. Some data have been collected for gravity-feed boilers, however, and are reported in the Section dealing with these appliances.

The wider field of coke utilization which has been developed by the Gas Industry has attracted many new manufacturers to produce coke appliances. Close co-operation with these manufacturers is necessary to ensure that the appliance is suitable for the quality and sizes of coke which can be economically produced and this indicates the need for an agreed standard for coke appliances.

F. B. RICHARDS
(Chairman of the Woodall-Duckham Companies).

Carbonization from a Plant Designer's Viewpoint

by

F. B. RICHARDS, M.B.E., M.Inst.C.E., M.I.Mech.E., M.Inst.Gas E.

(Chairman of the Woodall-Duckham Companies, London)

Mr. Francis B. Richards was apprenticed to Wm. White & Sons, of Cowes, and was also a pupil under Lieut.-Col. H. W. Woodall, Engineer and General Manager of the Bournemouth Gas and Water Company. He subsequently became Assistant to the late Sir Arthur Duckham in connexion with the design, construction, and operation of the Woodall-Duckham system of continuous vertical retorts. During the war Mr. Richards was Assistant Superintendent of the Government Rolling Mills, Woolston, Hants. In 1923 he was appointed a Director of the Woodall-Duckham Companies, Joint Managing Director in 1930, and Chairman (in succession to Sir Arthur Duckham) in 1932. He is a past Chairman of the Council of the Society of British Gas Industries.

Communication No. 181

In this Paper coal carbonization is looked at from a plant designer's viewpoint, and an attempt is made to indicate some of the factors which must be considered in the projecting and building of a modern carbonizing plant.

For each project it is necessary to decide what is the most suitable plant—and by "suitable" is meant the plant offering the maximum advantages from the technical, economic and psychological viewpoints. The broad headings under which a plant designer considers a project are dealt with.

In one section the diagnosis of individual requirements is discussed, including such factors as the type and grade of coal to be used, the calorific value of the gas to be made, the type of coke required, market for tar, size of installation, ground space available, local amenities, and degree of flexibility required in operation. Figures are included showing the comparative ground space occupied by various types of gas making plant.

The Paper gives a survey of the methods evolved, adapted, or adopted in the Woodall-Duckham Laboratories for the examination of the gas making and coking properties of coal and for the study of the behaviour of coal during carbonization. The methods described have stood the test of many years of practical application, both in connexion with Gas Works and coke oven projects, and have provided a reliable small-scale means of forecasting the behaviour of a coal under a variety of carbonizing conditions and the yields and quality of the products obtainable. Among the tests discussed are the crucible swelling test, the assay of coals, rate-of-swelling tests, and pressure swelling tests.

A section is devoted to a review of economic considerations. Factors influencing the cost of gas production are summarized, and information is given on the comparative capital costs for various forms of carbonizing plant. The subject of fuel economy on carbonizing plants is discussed, and calculations are given of the comparative costs of non-recuperative and fully regenerative continuous vertical retorts.

In the Paper it is pointed out that a plant designer must be able not only to design the individual units constituting the plant, but also to arrange the lay-out of the installation to the best advantage. Consideration is given to the subject of ventilation and lighting of the retort house, in order to secure comfortable conditions for the workers, and the recent tendency to improve the architecture of retort house buildings is discussed.

The Paper concludes with some general observations on the design and construction of the carbonizing unit itself. Reference is made to the valuable work of the various Research Associations set up under the Department of Scientific and Industrial Research, which have provided a better knowledge of the properties and limitations of the various materials available for the construction of carbonizing plants. Mention is made of the fact that the plant designer owes a deep debt of gratitude to those who day-by-day use the plant he builds. Much of the progress that has been made is due to the collaboration of designer and user, to their mutual advantage.

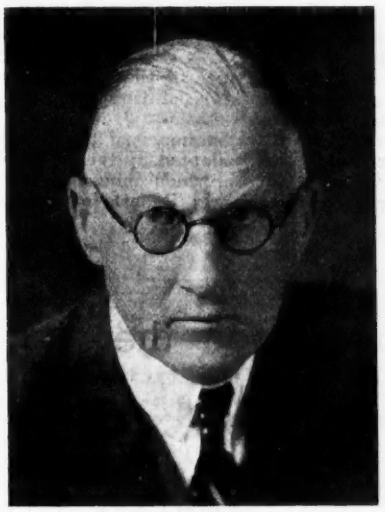
From Holder to Burner

by

W. J. SANDEMAN, M.Inst.Gas E.,

(General Manager, Croydon Gas Company)

After a few years with the Brighton Gas Company Mr. W. J. Sandeman joined the Croydon Gas Company in 1904 as Distribution Superintendent. In 1913 he became Distribution Engineer and Sales Manager, and in 1927 he was appointed General Manager—the position he now holds. Mr. Sandeman is Executive Chairman of the British Commercial Gas Association and a Justice of the Peace.



W. J. SANDEMAN
(General Manager of the Croydon Gas Company).

Communication No. 184

An outline is given in this Paper of the methods adopted by the Croydon Gas Company to deal with distribution and sales, two important sides of the Gas Industry.

Up to fairly recent times, the duties of distributing and utilizing gas were amalgamated in one department, known as the Distribution Department; but of late years it has been found necessary to divide the work, and the Author shows in this Paper how the technical features of distribution and the ever-increasing ramifications of selling call for divided responsibility in an Undertaking of the size of the Croydon Gas Company.

The officers in charge of each section, the Mains Superintendent and the Sales and Service Superintendent, are technical men, the former having had engineering training and experience, while the latter has a sound knowledge of commercial procedure and a practical understanding of the many problems which arise in the utilization of gas. There is close co-operation between these two officers, and the Paper shows how their duties link together.

It used to be said that " profits were made in the retort houses." While this was the case many years ago, today all departments share in the production of profits. The departments of manufacture, distribution, utilization and accounting are mutually dependent. Greater effort is, however, required further to develop the utilization of gas, with bigger and bolder sales policies and more thrustful methods, which call for the best young men procurable and demand for them carefully considered education and training. It is realized that the lay-out of a distribution network could well form the subject of a separate Paper, but as the purpose of this Paper is to give a general picture of the work at Croydon from holder to burner, rather than to deal with any one particular phase, it is not possible to go very deeply into details.

Works Control

by

W. HAWKYARD, M.Inst.Gas E., M.I.Chem.E.

(Works Engineer, Willoughby Lane Works, Tottenham and District Gas Company)

Mr. W. Hawkyard was educated at Huddersfield Technical College and the Manchester College of Technology. He was a member of the Bradford Road Works Staff of the Manchester Corporation Gas Department until 1927, when he left to take up his present appointment as Works Engineer at the Willoughby Lane Works of the Tottenham and District Gas Company.

W. HAWKYARD
(Works Engineer, Willoughby Lane Works, Tottenham and District Gas Company).

Communication No. 185

The scope of this Paper is limited to the particular methods of control practised at the Willoughby Lane Works of the Tottenham and District Gas Company. It is not intended that it should be a generalization on methods applicable to all or any Gas Works, since each has its own problems which are governed by situation, size, and similar factors.

The plant at the Willoughby Lane Works is described in the opening Section, details being given of the capacity and performance of the continuous vertical and intermittent vertical retort houses. The processing of coke on the coke screening plant is described in this Section and reference is made to the carburetted water gas plant and ancillary plant. This is followed by an outline of the methods used in the selection of coal supplies in order that the most satisfactory results may be obtained, and results of tests on the Gray-King apparatus are set out. A subsequent section relates to the control of the plant, with some observations on the main factors to be considered in the care and maintenance of retort settings, namely, purchase of suitable coal, regular working, and scurfing.

The subject of gas manufacture is dealt with in some

detail, including a full description of the two Whessoe/Woodall-Duckham detarrers, one treating carburetted water gas and the other treating the gas from the intermittent vertical chambers. Typical performance figures are given and the working costs of the two detarrers are compared. This Section also includes some notes on water supplies, gas drying and benzole recovery, and calorific values. The steps taken to ensure the regular examination and maintenance of gasholders are described.

A section is specially devoted to a review of the general Works conditions in so far as they affect employees, with particular reference to the measures taken to secure their safety. The general maintenance of the Works is considered, including such matters as painting and the care of tools, ropes, and other accessories.

The Author concludes with a summary of the carbonizing records and costing system adopted by the Tottenham and District Gas Company, and appends some specimens of cost sheets taken from the Yearly Report for the year 1937.

E. V. EVANS
(General Manager of the South Metropolitan Gas Company).

Considerations Upon the Processing of Coal

by

E. V. EVANS, O.B.E., F.I.C., M.Inst.Gas E.
(Chairman, Research Committee, Institution of Gas Engineers)

Communication No. 180

Mr. E. V. Evans, O.B.E., F.I.C., M.Inst.Gas E., now General Manager of the South Metropolitan Gas Company, was formerly Chief Chemist and Products Manager to the Company. The Author of several technical communications, particularly on the carbonization of coal, Mr. Evans was Cantor Lecturer to the Royal Society of Arts in 1924, is Chairman of the Association of British Chemical Manufacturers, and Chairman of the Research Executive Committee of The Institution of Gas Engineers.

This Paper is an attempt to forecast the effect which the growing and changing business of the Gas Industry may be expected to have upon the processes adopted for the production of a refined fuel from coal.

It is pointed out in the Introduction to the Paper that the matters discussed are largely of a theoretical nature and should be accepted as such.

The market for gas as a high priced fuel for special purposes has been developed assiduously in the past, but the possible demand for low priced gas as a staple fuel is immense and represents the Gas Industry's field of development. The production of coke simultaneously with gas is unlikely to assist in the development of this new business; it may in fact retard the production of cheap gas.

The features of an ideal gas manufacturing process are discussed. The future coal processing works should convert coal only to such forms of fuel as show a profit on the process, these being in most cases gas and liquid fuel. As wide a variety of coals as possible should be capable of treatment. The Works itself should be cleanly and compact. The operating costs should be so low that the gas costs not more than twice as much per therm as the raw coal purchased. Plant for the process should not cost more than about £500 per ton of coal per day. The composition of the gas should be maintained within close limits even though wide variations in output may be demanded. It is unlikely that it will be desirable for the composition of the gas to differ widely from that of coal gas.

Known processes for the complete gasification of coal depend upon the oxidation of the coke resulting from carbonization in air or steam or both. The gas is low in calorific value and of high carbon monoxide content. The production of a gas suitable for general use requires the removal of this carbon monoxide and its replacement by a hydrocarbon gas or gases. Methane is the hydrocarbon gas most likely to serve this purpose.

Believing that it should be possible to discover a means of obtaining from a ton of coal more valuable products by less ruthless treatment experiments have been made to this end. An enhanced yield of hydrocarbon gases may be obtained by controlling the conditions of tar cracking during carbonization, especially in the presence of hydrogen. The same principle may be extended to the production of rich gas from low temperature tar, but by no such means has it proved possible to produce enough gaseous hydrocarbons to enable the coal to be converted entirely to gas of high calorific value. This work has shown the necessity for adding hydrogen to the coal before its conversion to gas, and this is not likely to be achieved without resort to pressures of several atmospheres.

A new line of progress was suggested by the development in Germany of a process which employed pressures of several atmospheres to influence the course of chemical reactions leading to the synthesis of hydrocarbons and employing at the same time oxygen which was produced at a price of economic interest.

Operation under high pressures permits a striking reduction in size and simplification of the ancillary plant and mains. The advantages in distribution are obvious. Purification of the gas is effected almost wholly by washing with water. Cleanliness of operation becomes a natural feature. The output of a plant is high in relation to its size and chemical reactions are influenced in a desirable direction.

Because the processes developed in Germany are not, as they stand, adapted for using bituminous coals the underlying reactions have been subjected to study. In the course of this work it was found by Dr. F. J. Dent at Leeds that hydrogen under a pressure of several atmospheres reacted with partially carbonized coal or coke to produce large quantities of the hydrocarbon gases desired. Hydrogen may be produced cheaply at the required pressures by the action of oxygen and steam on the residue from the hydrogenation process. Coals of widely different character have been treated by the process and a high rate of gasification is possible. The experimental results indicate the possibility of obtaining from a ton of coal some 160 to 180 therms of 500 B.Th.U. gas together with 27 gal. of tar and sufficient hydrogen for the conversion of the tar to lighter oils.

THE PAPERS TO BE PRESENTED

Six Communications are to be presented at the Institution Meeting next week. Three of these, Nos. 180, 183, and 184, we publish *in extenso* in the following pages; the others are slightly abridged. The Communications are issued as Institution "blue books," and are obtainable on application to the Secretary, Dr. W. T. K. Braunholtz. A full report of the Discussions on the Papers will appear in our Second Institution Number on June 8.

Considerations Upon the Processing of Coal

Communication No. 180

by

E. V. EVANS, O.B.E., F.I.C., M.Inst.Gas E.

(Chairman, Research Executive Committee, Institution of Gas Engineers)

INTRODUCTION

When, recently, the Author was asked to deliver an Address before the Royal Society of Arts, he took the opportunity of dealing with the immensely important part that the Gas Industry plays in the life of the community, not only in effecting a wise use of the natural resources of the country but also in contributing largely to the amenities of life and to the progress of industry.

At the 1937 Annual Meeting of the British Commercial Gas Association, S. C. Leslie described in detail what was being done at Kensal House and pointed to this estate as a demonstration of the improved conditions of living which the Gas Industry can make possible. In South London there is Sassoon House, which offers a similar object lesson to those who may be still in doubt. These examples show beyond question that smoke is an unnecessary evil today because the Gas Industry is able to give a smokeless fuel service at a cost well within the means of the weekly wage earner. As one associated in an official capacity with the conduct of a Gas Undertaking, the Author is convinced that there is a very great field for development open to the Gas Industry *using the methods of procedure and the coal carbonizing processes which are at present employed.*

At the same time the Gas Industry could not be considered as progressive or gas engineers as worthy representatives if they were to accept the present position as their final achievement. There are many indications that the service which the community will require of the Gas Industry in the future may be vastly greater than that which it performs today, and gas engineers would be failing in their duty if they did not explore, with every means at their disposal, the possibilities of development in new directions. Such enquiries and speculations should, of course, never be allowed to influence or to distract the attention of gas engineers from their present duties in the day-to-day conduct of Gas Undertakings. Still less should the vision of a possible future be permitted to outshine the importance of a present reality, but while they are dwelling comfortably in the house of 1938 they should at least be preparing the plans for the larger dwelling that the future will need.

In all attempts to explore the path of progress there is a danger that possibilities may be interpreted as probabilities and probabilities as certainties, while the most fantastic schemes come to be considered good material for debate. The Author is well aware of these pitfalls and would warn those who may see in the prospects he wishes to present a sudden and cataclysmic change. The Gas Industry of today is a responsible organization entrusted with the operation of an efficient process and the rendering of a reliable and adequate service. Whatever changes may come will come by the secure and gradual methods of evolutionary growth and not by drastic and sudden revolution. There could be no question, for example, of abandoning existing efficient carbonizing plant.

With this introduction and necessary warning the Author desires to divorce himself temporarily from his position as an official of a Gas Undertaking and to explain to members of the Institution, as Chairman of their Research Executive Committee, some considerations which are influencing the course of its developmental work.

The problem that must persistently present itself to the technically—and particularly to the chemically—trained mind in the Gas Industry is whether each ton of coal is treated with due regard to the conservation of its potential thermal value and whether the products obtained are those best suited in every respect to meet the requirements of the community. In this communication, therefore, an attempt has been made to collect together a number of facts, both technical and economic, relating to the processing of coal and to deduce from them certain lines upon which the manufacture of gas might be expected to develop.

GAS AND ITS COMPLEMENT, COKE

Evidence of the interest in matters relating to the processing of coal is shown by the technical and financial efforts made to improve the distribution of electrical energy, to develop the process of coal hydrogenation and to extend the practice of the low temperature carbonization of coal. More recently public interest has been aroused again on the subject of smoke abatement or, as many now prefer to call it, smoke abolition, and the achievement of this ideal, with its unquestioned benefits to national health, amenities and economics is a task which the Gas Industry is peculiarly well-fitted to undertake; in fact, none but the Gas Industry can offer an economic and therefore complete solution. Without doubt it is in this direction that future expansion must lie, and it is just because the field of expansion and of greater service to the community is so large that a re-examination of the methods of coal processing is opportune.

From the commencement of its history until the recent past the Gas Industry has been a supplier of a luxury* fuel. This term is intended to convey the idea of a form of fuel so refined and so convenient in its application that it can be used in circumstances where a crude fuel would be objectionable or even impracticable. Gas, having these special attributes of cleanliness and convenience, merits a considerably higher price per thermal unit than raw coal. Thus one may compare the price of, say, 9d. per therm for gas with a price of, say, 2d. per therm for coal, and find that, when it comes to matters such as cooking

* The term "luxury" is used here in the sense in which it would be used by a student of economics to distinguish any commodity which adds to the amenities of life from those which represent the bare necessities of life. It is the basic object of rational gas pricing to remove gaseous fuel from the category of a luxury and, by making it available at a sufficiently low price, to cause it to be recognized as a necessity.

and water heating, the cleanliness and convenience of the luxury fuel amply justify the higher price.

Today the fact must be recognized that there are available, both to industry and to the domestic user, two forms of luxury fuel or energy, gas and electricity, each having its own peculiar attributes. In past years the Gas Industry has explored and developed to a high degree the market for a luxury fuel and the entry of a competitor into this field must, of necessity, cause some restriction of the market available to gas at the luxury fuel price. The great strength of the Gas Industry lies in the fact that it is able to *produce* a luxury fuel at a price which makes it competitive with crude fuel. Recognition of this fact has given rise in recent years to the tendency for Gas Undertakings to modify the flat rate method of charge, and it is probably no exaggeration to say that the expansion and even the maintenance of gas sales depends upon a rational system of pricing being adopted. With such a system in existence the luxury fuel, which has but a limited and diminishing market at the higher price, has a great and extending market at prices more in accord with its cost of production.

The consideration of such facts leads inevitably to the conclusion that the future of gas lies not so much in its extended use in the luxury fuel market but in its recognition and use as the staple fuel. When one looks at the annual fuel requirements of a domestic user living in one of the dwellings erected in recent years, one finds that it includes some 400 units (13·6 therms) of electricity and some 90 to 100 therms of gas. In addition this consumer will probably employ raw coal to the extent of 500 to 600 therms annually, this representing his staple fuel.

Gas and electricity thus play a relatively small part in supplying the total requirements. The overhead charges involved in providing two alternative services for two alternative luxury fuels would not give the consumer the best value for his money if both these services are used only to a limited extent. If, however, it is assumed that the commodity supplied by one of these services is capable of a far freer use than that of the other then there can be no question of the necessity for providing that commodity.

The Use of Coke

It may be considered that the Gas Industry can meet the increasing desire for a cleaner atmosphere by extending its sales of coke in the domestic market, and that so long as it is selling something like 100 therms of gas per annum to each domestic consumer it is performing its duty in making available to the public an adequate fuel service. Undoubtedly the extended use of coke in conjunction with gas can do very much to alleviate the present smoke troubles but one must be prepared to consider that the Gas Industry should regard the combined use of coke and gas as a phase which, though satisfying the conditions of today, may not always be regarded as adequate. The reasons for this view may appear self-evident but it is no waste of time to enumerate them.

First there is the fact that the replacement of coal by coke is only a partial solution of the problem of atmospheric pollution. In addition, coke does little to ease the work of the housewife, except in so far as it enlists the aid of gas for ignition purposes, is usually burnt in a grate of good design, and avoids the necessity for visits from the sweep. Nor does the use of coke instead of coal contribute anything to the solution of the problems of storage and transport, matters which are costly and difficult in the crowded cities of today. These remarks are not intended in any way as derogatory to coke as a substitute for coal—such a substitution is a material advance—but only to draw attention to the fact that coke does not form a final solution to the problem of providing a refined fuel in place of raw coal.

Economics of Coal Processing

It is necessary to consider this question of gas and coke from the point of view also of the economics of coal processing. As the Gas Industry gains more experience in devising tariffs, which will allow the public to appreciate the advantages of using a refined fuel at a cost per effective therm no greater than that of a crude fuel, a satisfactory system of recovering the overhead charges of the Undertaking will come into being, and it is desirable, for the purposes of this Paper, to assume that the attendant difficulties have been solved and that tariffs offering supplies of gas at a low commodity rate are available. It is then pertinent to consider what the repercussions of these newer methods of selling gas may be upon the economics of the manufacturing process itself.

Because the manufacture of gas has centred hitherto in the production of one main product which sold at a high price compared with the cost of the raw material, the accounts of Gas Undertakings have been kept in a manner consistent with this conception. If the Gas Industry is to change from being the producer of a limited quantity of a luxury fuel to being the producer of a large quantity of a staple fuel, it is necessary to look at the accounts from a different point of view.

The manufacture of gas becomes a process for which a quantity of raw material is purchased at a certain price. The raw material is subjected to treatment in appropriate plant at a certain cost and certain products are obtained as the result of the treatment. Clearly the whole of the costs of the raw material and of the costs incurred in processing must be recovered in the enhanced value of the products, and the economics of the manufacture will not be on a very secure basis unless at least the greater part of the products contribute their fair share to the total cost.

It is instructive to see how the existing processes of gas manufacture appear when regarded from this point of view, but in doing so it has to be remembered that *the commodity in which a Gas Undertaking is really interested is heat, not coal or coke or gas as such, and the accounts must therefore be on a thermal basis.*

A Gas Undertaking in a district some distance from the collieries will purchase 300 therms in the form of coal for some 25s., that is, 1·00d. per therm. In processing the coal by carbonization and in purifying the gas and preparing the coke for sale some 150d. will be spent,* making a total expenditure, exclusive of capital charges, of 450d. per ton of coal. During the processing some 72 of the 300 therms will have been used for heating the retorts, for steam raising and for such purposes, leaving 228 therms available for sale. The average cost of each therm of the manufactured products is therefore $\frac{450}{228}$d. = 1·97d., to which should be added the charge for capital. It may be assumed that of the 228 therms available for sale 135 therms will be in the form of coke, 18 therms as tar, and 75 therms as gas. The 135 therms in the form of coke will realize about 1d. each (22s. 6d. per ton), and the 18 therms in the form of tar will sell for 1·85d. each (3½d. per gal.).

Regarding the process still on a thermal basis there is a working loss of 0·97d. on each therm in the form of coke and a working loss of 0·12d. on each therm of tar. In order that the business may remain solvent it is necessary that the therms in the form of gas should be sold at their cost price plus an addition to cover the loss on coke and tar and they must also carry the whole of the capital charges. In this manner the cost of a therm of gas is ascertained as 1·97d. (its own cost of production) plus 1·78d.† (its contribution to the deficit on coke and tar), making a total of 3·75d. plus the charge for capital.

Where figures such as these exist it would clearly not be a paying proposition to purchase coal and to carbonize that coal in order to produce coke, unless there were a certainty of selling the gas at a luxury price. Circumstances similar to those discussed exist in many towns and in such circumstances the very production of coke on an economic basis depends upon a continued ability to obtain a luxury price for gas. If it is true that the future development of the Gas Industry lies in selling gas as a staple fuel, and at a price that will be paid for a staple fuel, the

* This includes wages and salaries, repairs, purification, and rates and taxes. The figures are approximated from the average results of "Company Undertakings" in Field's Analysis.

† $\frac{(135 \times 0{\cdot}97) + (18 \times 0{\cdot}12)}{75} = 1{\cdot}78.$

Industry will no longer be in a position to afford the continued production of coke.

The noteworthy success in the expansion of gas sales in certain industrial districts is sometimes discounted by remarking that such things are easy with cheap coke-oven gas at hand. The fact remains that someone has found a way to produce gas cheaply and this fact cannot be credited wholly to the type of carbonizing plant employed. It is much more largely a matter of selecting a process the economics of which are suited to local conditions such as the relative local prices for coal and for coke.

In making a comparison between the costs of coal processing at a Gas Works and those of a similar operation at a coking plant it must not be overlooked that, in providing for the seasonal variations in output and in purifying and storing the gas, a Gas Works meets responsibilities that do not apply to a coking plant. Bearing this in mind it may be said that the economic operation of coke ovens depends upon the fact that the price obtained at works for a ton of coke is $1\frac{1}{2}$ to $1\frac{3}{4}$ times that paid for a ton of coal. It may be added that the economics of low temperature carbonization may be summarized generally by a similar statement in which the price ratio per ton is about 2. It should be noted that the relevant figure for the value of coke is the value *at works* and not the selling price. Unless a Gas Undertaking can see its way to a similar economic position the production of coke will be a charge upon the production of gas.

Further, if both fuels are to be sold by the one industry for the same purposes (that is, purposes for which a staple fuel is used), then there will be the rather absurd spectacle of two mutually competitive products being marketed by the same industry, one of these being subsidized by the other. Incidentally, the one that receives the subsidy would be the one less capable of giving perfect service.

To summarize, with gas at a luxury price the public needs coke as its complement, but gas as a staple fuel does not need nor can it afford a complement.

DESIDERATA OF GAS PRODUCING PROCESSES

The considerations presented in the previous Section suggest that gas producing processes as they exist today, excellent though they are, do not represent the ideal methods of processing coal and, since up to this point known processes have been subjected to criticism, it will now be helpful to consider the features which one would expect to find in an ideal gas producing process. In suggesting the following desiderata no attempt is made to indicate the relative importance of each factor. Indeed, the factors are so interrelated that a preferential degree of importance cannot be given.

It is desirable that a process for converting coal to gas should be as catholic as possible in its use of raw materials. Coal carbonization by existing methods requires the supply of good coking coal and, in order that the quality of the coke shall be acceptable, the ash content of the coal must be limited. If gas is to be used for industrial and domestic purposes in place of raw coal it is clearly desirable, both in the interests of the Gas Industry and of the coal industry, that the conversion should be made by a process treating all or any of the varieties which are now burnt in the raw state.

The desirability of avoiding the incidental production of solid fuel has been discussed already, and this feature may be accepted as an essential one to the ideal process. The only exception will occur if, by reason of the special properties of the solid fuel, or by the local circumstances of the Gas Undertaking, the solid residue can be sold at such a price that its cost of production is not a charge upon the cost of production of gas.

The thermal efficiency of the process should be high, not less than, say, 70 per cent. This factor is important both from the point of view of the wise use of the raw material and in order that the gas produced shall not be required to bear the cost of an inordinate loss in processing.

A consideration which is not yet of major importance, but which will undoubtedly be receiving far more attention in the future, is the cleanliness of the process. A great deal has been done in this direction in recent years, and modern installations of carbonizing plant are designed with due regard to their appearance and cleanliness, but there still remains much to be done.

The operating costs should be low enough to enable the gas to be produced at a cost, excluding capital charges, not exceeding twice the cost on a thermal basis of the coal; that is to say, with coal purchased at 1d. per therm, gas should be produced at a figure, excluding capital charges, of not more than 2d. per therm. In order to meet this condition, an orthodox carbonization process yielding 75 therms of gas per ton would make available only 75d. per ton to cover all working expenses, which include the wages and materials expended in processing, the loss of thermal value in processing, and any deficit in revenue from secondary products. Now if the coal were gasified completely with a thermal efficiency of 70 per cent. a yield of 210 therms of gas would be obtained, which would provide 210d. per ton of coal to meet the loss in processing and the processing charges, while obviously there could be no deficit on secondary products.

It is difficult to speak of the permissible capital expenditure required for the processing plant until one has at least a general idea of the nature of the process, but it is important to remember that the capital cost of a plant is decided more by the tonnage of coal to be handled than by the output of gas and, from this aspect, an enhanced yield of gas per ton of coal reduces the capital cost per therm of gas. Experience of present-day carbonizing plants suggests that a figure of £500 per ton of coal per day for the entire plant represents a capital cost which it is undesirable to exceed. A yield of 210 therms of gas in place of 75 therms would then reduce the incidence of the capital charge per therm in the ratio of 210 : 75.

If the capital and working costs could be kept within the limits suggested, the sale of gas at a really low price to industry and to the domestic user would make it possible for gaseous fuel to be used almost universally in place of solid fuel. What this could mean to the Gas Industry as a whole in the extension of gas sales has been demonstrated beyond question by the progress that has been made in recent years in the gas output of such cities as Sheffield and Newcastle.

So far no reference has been made to the quality of the gas which the ideal process should produce and this is a matter upon which there has been a wide divergence of opinion. Although there is little support for the adoption of calorific values below 300 B.Th.U. per cu.ft., and while there are few who would recommend the production of a gas having a calorific value as high as natural petroleum gas there will be found supporters of proposals for supplying gas of any calorific value lying between 300 and 600 B.Th.U. per cu.ft. If, however, one may judge from the actions of Gas Undertakings which, since 1920, have been free to choose that calorific value which gives greatest mutual satisfaction to themselves and to their consumers, it would appear that the general opinion favours a calorific value within the inclusive range 450 to 560 B.Th.U. per cu.ft., with a distinct preference for the range of 475 to 525 B.Th.U.

Now it may be that, to some extent, the selection of this range has been brought about by the necessity for making the best use of existing plant and processes and for balancing the quantity of coke made against the local demand. Other reasons may include considerations of the flexibility of gas output, or the utilization of coals available locally at an attractive price.

Whatever may be the special reasons in individual cases, the fact remains that the majority of distributing systems and the majority of gas appliances throughout the country today are designed with a view to the use of a gas having a calorific value somewhere within the range 450 to 560 B.Th.U. per cu.ft. and consisting of some 45 to 55 per cent. of hydrogen, 20 to 30 per cent. of methane, 6 to 18 per cent. of carbon monoxide, 8 to 16 per cent. of non-combustibles, and 2 to 4 per cent. of heavy hydrocarbons. The composition of gas which would give the greatest universal degree of satisfaction to the gas consumer and would permit the greatest flexibility in the design of gas appliances cannot be predicted in the present state of knowledge, and the Joint Research Committee of The Institution of Gas Engi

neers has considered this matter of sufficient importance to undertake an exhaustive study of the subject.

Without attempting to prejudge the outcome of this work, certain general trends may be accepted without much question. Any large quantity of inerts is likely to prove undesirable in that it is a useless addition to the cost of distribution and reduces the flame temperature attainable at the consumer's appliance. Moreover, it is necessary to remember that the quantity of gas which may be required to pass the meter of an " all-gas " house can amount to as much as 1½ to 2 therms per hr. for short periods. This demand is obviously more easily met satisfactorily when the volume of gas represented is 300 to 400 cu.ft. per hr. (500 B.Th.U. gas), than, say, 750 to 1,000 cu.ft. per hr. (200 B.Th.U. gas).

The distribution of a gas containing a high proportion of heavy hydrocarbons is also improbable in this country in the absence of any readily available source of such gases. It would seem permissible to assume that the major constituents of the gas most suitable for distribution are likely to be, as at present, hydrogen, carbon monoxide and methane. These three gases show a remarkable diversity in their combustion properties, the essential features of which may be summarized as in the following table:

Combustion Properties of Hydrogen, Carbon Monoxide and Methane

——	Hydrogen.	Carbon Monoxide.	Methane.
1	2	3	4
Calorific value	Low	Low	High
Specific gravity	Low	High	Medium
Flame speed	High	Low	Low

The well-marked characteristics of each and the extent to which these characteristics depart from those of most town gas supplied today render it improbable that any one alone would give universal satisfaction, but it would seem that whatever characteristics may ultimately be considered ideal for a gas supply for general fuel purposes, it should be possible to obtain these properties by the judicious blending of these three gases.

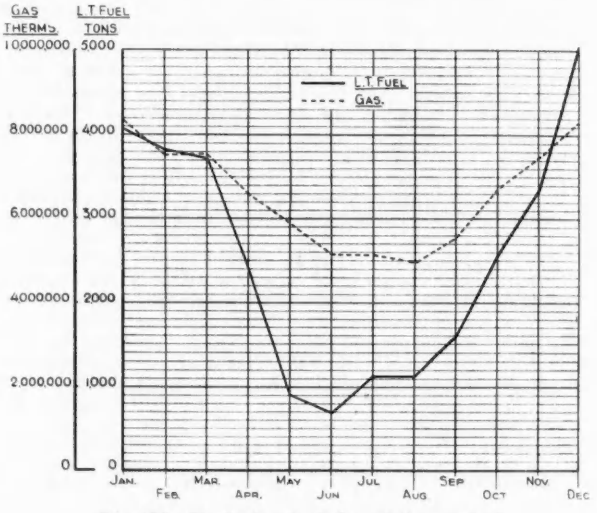
The fact must not be overlooked that carbon monoxide is a poisonous gas, whereas hydrogen and methane are not. The desirability of limiting the amount of carbon monoxide permissible in town gas has received much consideration and the Home Office and the Board of Trade have at various times appointed Departmental Committees to consider this question. The Home Office Committee reported in 1898, and the Board of Trade Committees in 1921 and 1930. In each Report emphasis was given to the undesirability of hampering development of the Gas Industry by any restrictions imposed upon it from without as to the composition of gas supplied, and the evidence showed that the actual number of fatalities from gas poisoning was very small in proportion to the number of people enjoying the advantages of gaseous fuel, and this was largely due to the care and supervision exercised by responsible Gas Undertakings.

Nevertheless, it would be unwise for the Gas Industry to overlook the fact that the 1930 Report of the Board of Trade Committee left the onus for maintaining and increasing the safety of gas and gas appliances upon the Industry itself. Having regard to the confidence that has been placed in the public spirit and enlightened foresight of the Gas Industry, it does not seem likely that the proportion of carbon monoxide in town gas will be increased. Rather must a marked tendency towards lower concentrations of this constituent be expected.

Having regard to all these considerations, it appears not unlikely that the gas which will be found most suitable for general distribution will differ but little from the composition of straight coal gas, that is to say, substantially a mixture of two volumes of hydrogen with one of methane, with, in addition, small quantities of carbon monoxide, heavy hydrocarbons and non-combustible gases.

Of one thing one may be certain; *the combustion characteristics and chemical composition of the gas, having once been decided, should be maintained constant, and flexibility of output should be obtained without sacrifice of constancy in gas quality.* This is a big consideration, because the adoption of gas as a staple fuel will almost certainly result in greater seasonal variation in the demand, and the ideal process will be one that meets these variations economically and without detracting from the uniformity of the service given to the consumer.

The accompanying figure is of interest in this connexion as it shows the monthly variation in sales of a low temperature coke sold exclusively for domestic purposes. For purposes of comparison the gas output curve for the same district of supply is shown on the same chart. The very large swing from summer to winter might be taken as an argument against attempting to displace solid fuel by gas, but the Gas Industry cannot pretend to be performing its duty to the public if it is not prepared to adapt its processes to meet the reasonable requirements of the consumer. Flexibility of output is clearly one of the main desiderata of the processes which are being sought.



Monthly Variation in Sales of Gas and of a Low Temperature Domestic Coke.

EXISTING COMPLETE GASIFICATION PROCESSES

Prior to 1920 the Gas Industry as a whole in this country had little interest in processes of complete gasification, but the passing of the Gas Regulation Act and the greater freedom which it afforded in the choice of calorific value gave the opportunity, while the rapid decline in coke prices during 1921 and 1922 gave the incentive for a greater interest in the possibilities of such processes.

Both in this country and in Germany a good deal of ingenuity has been expended in devising various arrangements of plant and methods of operation, but they may all be regarded essentially as variants of one of two systems.

The first system is that of the gas producer in which the hot gases from the reaction zone pass through the incoming coal and distil from it the gas and tar, the distillation gases mixing with and enriching the producer gas made from the coke. A considerable quantity of coal is gasified by this method at the present day; although not usually by statutory Gas Undertakings, the outstanding exception being the South Staffordshire Mond Gas Company, which supplies upwards of 5,000 mill. cu.ft. of producer gas annually for industrial purposes. Gasification by this method is cheap and thermally efficient, 75 to 80 per cent. of the thermal value of the coal being recovered in the gas and tar. The process possesses high flexibility in output and can be operated with very little nuisance from smoke or grit, but the gas produced is of low calorific value (less than 200 B.Th.U. per cu.ft. and usually below 150 B.Th.U.) owing

to the presence in it of the nitrogen contained in the air used for gasification. Where large quantities of gas are used on the same Works in which they are generated and in furnaces provided with recuperators or regenerators this fact is of less importance than the low cost of production, but it would detract from its suitability for purification and distribution as town gas.

The second group of processes operates by combining carbonization with the production of water gas. The carbonization of coal in a carbonizing plant combined with the gasification of the coke in water gas generators is the prototype of this system and yields a mixed gas having a calorific value of about 360 B.Th.U. per cu.ft. The gas produced by this type of process is low in non-combustible constituents but the thermal efficiency, as a rule, tends to be low. In its simplest form coal is carbonized in a plant of orthodox design, and the coke is discharged, cooled and conveyed to the water gas generators where its temperature must again be raised to about 1,000° C. The heat required for the carbonization of coal in the first place, for raising the temperature of the coke in the water gas plant to the reaction temperature and for supplying the thermal energy required by the endothermic reactions of gasification, must all be obtained by combustion of a portion of the coke, and a considerable proportion of the original heat in the coal is lost in so doing. The final result is that not more than 60 per cent. of the thermal energy contained in each ton of coal appears in the form of gas. A great deal of ingenuity has been applied to improving the thermal efficiency of the combined process and to effecting simplification of the apparatus required. The first obvious step is to discharge the hot coke direct from the carbonizing vessels into the water gas generators, and the second is to use the sensible heat contained in the gases from the water gas generators to effect the carbonization of coal. The amount of sensible heat carried in the water gas alone is insufficient for this purpose and some assistance is necessary from the heat contained in the blow gases. By the adoption of these devices in one form or another the thermal efficiency of complete gasification by this system has been raised to some 70 per cent.

Processes consisting of a combination of carbonization and water gas manufacture are generally more costly in plant and of lower thermal efficiency than processes of producer gas production, but they have the advantage that the non-combustible content of the gas is lower and the calorific value higher, yet not so high as to warrant distribution without enrichment.

The gas from both types of plant contains some 30 to 35 per cent. of carbon monoxide and, although this is no disadvantage if the gas is to be used for industrial purposes, its distribution in the town mains would not be welcomed. From what has been said of these existing complete gasification processes it is apparent that, to a very limited extent, they are employed by the Gas Industry today. Very many Undertakings augment the quantity of coal gas by the addition of blue water gas, producer gas, or carburetted water gas, but it is doubtful whether many would find it economic to gasify the whole of their coke in a carburetted water gas plant, as is common practice in the United States, or to adopt the complete gasification process described by C. F. Broadhead to The Institution of Gas Engineers last year.*

In the United States, oil for enrichment is available at a low price, although one must recognize that the very circumstances which have made its price low have also made supplies of natural gas available. In the circumstances described by C. F. Broadhead the production of a complete gasification gas of 500 B.Th.U. per cu.ft. is rendered possible by there being available large supplies of brown coal tar. Without enrichment the calorific value is not likely to exceed 360 B.Th.U. per cu.ft. but it is apparent that, in this country, if it is desired that an enriching medium should be used in any large quantity it must be obtained from the coal itself and *the problems to be solved in devising a satisfactory system of complete gasification centre in the reduction of carbon monoxide and the production of a hydrocarbon gas or gases to increase the calorific value and confer the necessary combustion properties.*

* Inst. Gas Eng. Communication No. 153, 1937

SOME ATTEMPTS TO INCREASE THE YIELD OF HYDROCARBONS

Although it is probably true to say that there is no known way in which better use can be made of a ton of coal than by subjecting it to carbonization at high temperatures, it is the duty of the Gas Industry to ascertain whether a still better way could not be devised. Greater use of the raw material would probably be made if coal could be treated less ruthlessly and in such a manner that the chemical reactivity of the original coal substance could be better conserved.

It seems unfortunate that, in the process of high temperature carbonization, coal possessing high chemical reactivity should be subjected to such treatment that nearly three-quarters of it is converted to coke which shows a far lower chemical reactivity. Perhaps it is because of the low reactivity of high temperature coke that processes of low temperature carbonization have appeared to many people to be so interesting, and indeed these processes do succeed to some extent in conserving the original reactivity of coal in the solid as well as in the gaseous and liquid products.

The idea that it ought to be possible to obtain more from a ton of coal than is obtained at present has been behind a good deal of experimental work with which the Author has been associated, and it may be of interest at this point to refer to certain aspects of these investigations.

An integral part of the work consisted in studying the properties of coke and the influence of its method of production upon its final chemical reactivity. The conclusion was reached that the low reactivity of high temperature coke was the inevitable consequence of the heat treatment to which the coal was subjected in the process of high temperature carbonization, and experimental results caused the formation of coke to be regarded as a progressive modification of the chemical structure of the *coal substance.*

Indeed, it may be stated generally that the final reactivity of the coke is dependent upon the manner and degree of the heat treatment of the coal. The chemical structure of coal is one in which the benzene ring nucleus plays a prominent part, and the high chemical reactivity of coal arises from the linking of these relatively inert nuclei by reactive chains containing carbon and hydrogen, together with some oxygen, nitrogen, and sulphur. Carbonization at low temperatures up to 700° C. (by the elimination of gases and liquids richer in hydrogen than the original coal) reduces the length and number of these reactive chains, although they are not removed completely. On heating low temperature coke to above 700° C. much hydrogen is evolved, and the residues of the reactive chains, which act as "spacing" atoms between the nuclei, are eliminated. This is accompanied by a striking change in the physical and chemical properties of the coke. Adjacent rings of carbon atoms, no longer separated by hydrogen, have fused together with the production of a chemical structure of a very stable nature and consequently of low chemical reactivity.

Less Ruthless Treatment of Coal

This description of the chemical changes which occur during the conversion of coal to coke, though brief and necessarily far from complete, permits a closer definition of what is meant by a "less ruthless treatment of coal". The drastic heat treatment of high temperature carbonization is now seen as a process in which hydrogen atoms are torn from between carbon atoms, leaving the latter to pack together into a chemically stable mass. A less ruthless treatment would ensure that elemental hydrogen was not separated from the coal as such, but that each hydrogen atom remained attached to a carbon atom or atoms in such a manner as to keep these carbon atoms in a chemically reactive state.

From what has been said it will be appreciated that this more gentle treatment of coal must take place below about 700° C., because once this temperature has been

exceeded to any great degree the damage has been done and the carbon has been converted to a less reactive state.

One instance may be given in which the application of this principle of less ruthless treatment gave interesting results when used to modify the yields of hydrocarbon gases obtained by the carbonization of coal. During the earlier stages in the carbonization of coal, that is, at temperatures below about 480° C., there is produced a primary tar of a nature somewhat resembling low temperature tar. It is by the thermal decomposition of this tar that a large proportion of the hydrocarbons in coal gas results, because when coal is carbonized in horizontal retorts the primary tar vapours are subjected, very soon after their liberation from the coal, to the greater temperatures existing near the retort walls. If these temperatures are too high the tar vapours may be decomposed completely to hydrogen and to coke or retort carbon of low reactivity.

In ordinary carbonizing practice a proportion of the vapours suffers this fate, while the remainder escapes this extreme treatment and yields hydrocarbon gases, together with high temperature tar which is richer in carbon and poorer in hydrogen than the primary tar from which it was formed. It was found in the experiments that, if these vapours of primary tar, straight from the coal, were treated so as to minimize the separation of free hydrogen, an appreciably enhanced yield of gaseous hydrocarbons could be obtained. The treatment consisted in controlling quite closely the temperature to which the tar vapours were subjected and, at the same time, maintaining such a concentration of hydrogen in the cracking chamber that the tendency of the tar to produce free hydrogen was restrained. In this manner such a yield of hydrocarbons was obtained as would permit the addition of hydrogen or blue water gas to an extent to give a total yield of 90 to 95 therms of 560 B.Th.U. gas from a ton of coal. Using Pexton's convenient criterion of Hydrocarbon Enrichment Value to express these results it can be said that the H.E.V. was increased from 36 to over 44. These experiments showed that, at least so far as the tar was concerned, the efforts to prevent hydrogen escaping from its combination with carbon had given a useful improvement in the yield of hydrocarbon gases.*

It will have been noticed that, in these experiments, the vapours of primary tar were being dealt with immediately after they left the coal, and this is regarded as an essential feature of the treatment, since it was known that if these tars were allowed to condense it was not a simple matter to vaporize them again without decomposition and consequent reduced yields. For this reason the tar obtained from the carbonization of coal at low temperatures is not readily utilized as a source of gaseous hydrocarbons, but it was thought that if this tar could be vaporized without decomposition it could then be subjected to cracking at controlled temperatures and in an atmosphere rich in hydrogen, and results obtained similar to those from the cracking of the primary tar vapours.

In order to achieve the distillation of low temperature coal tar without decomposition a form of pipe-still was devised in which the tar was admitted together with such a quantity of gas that conditions of turbulent flow existed throughout the pipes of the still. The tar and gas passed through the still as a foam, and local overheating at the walls of the tube was prevented. By this means it was found possible to distil low temperature tar to the extent of 90 per cent., leaving only 10 per cent. of pitch. The next step was to combine this method of distilling low temperature tar with a system of tar cracking, and as it was realized that the tar itself contained insufficient hydrogen for all its carbon to appear as gaseous hydrocarbons in a process of simple cracking, an atmosphere of hydrogen was maintained.

During the experiment it was found that some 2,200 cu.ft. of hydrogen was absorbed in treating each ton of tar. It may be said, therefore, that not only was hydrogen prevented from escaping from its combination with carbon, but, to a certain degree, union was taking place between extraneous hydrogen and the carbon of the tar. Although some degree of hydrogenation had taken place, it will be seen from these figures that it is but small, and this experiment, together with others of a similar nature, showed the improbability of any considerable quantity of hydrogen combining with tar and still less with coal or coke at *atmospheric pressure*.

* In view of some later developments it is interesting to observe a note made at that time to the effect that there was an apparent absorption of hydrogen by the coke at 600° C. This was attributed to diffusion of hydrogen through the silica tube employed. A metal retort was then used and a similar loss was noted and avoided by using nitrogen instead of hydrogen at the higher temperatures. As a result of the work at Leeds the explanation of this observation is now apparent.

The Bergius Process

It was natural that, at this point, attention should turn to the efforts made by Bergius to introduce additional hydrogen *under pressure* into the coal molecule and thus produce liquid fuels. The objective was fundamentally the same as his, but the Author wished to go further and not stop when sufficient hydrogen had been introduced to liquefy the coal. Instead, it was thought that it should be possible to cause at least the greater portion of the carbon in the coal to combine with sufficient hydrogen to convert it to gaseous hydrocarbons. The possible value of hydrogenation processes in gas manufacture had not been ignored previously, and when, just after the war, a syndicate was formed to develop the processes invented by Bergius the Gas Industry was well represented in the venture.

When the prospects of the processes were reviewed in 1927 there did not seem to be any likelihood of a successful commercial development of the Bergius process for the hydrogenation of coal as a gas manufacturing process because, at that time, the greater part of the product was a heavy oil which would have been no more than a substitute for crude natural petroleum. Largely because of this the Bergius syndicate was dissolved in 1927 and the patent rights taken over by Imperial Chemical Industries Limited.

High Pressure Hydrogenation of Tar

By 1930 the experiments on the cracking of tar had suggested that high pressure hydrogenation might prove a valuable tool in the production of gaseous hydrocarbons and it was decided to undertake an investigation in co-operation with the Chemical Research Laboratory, Teddington, making use of the same principle as was employed in the distillation of low temperature tar, namely, the production of a foam of gas and liquid by passing them through a tube together under conditions of turbulent flow. It was considered that this intimate contact might facilitate the absorption of hydrogen by low temperature tar. The ultimate object here, as in all this work, was the production of hydrocarbon gases from coal, but it was expected that by studying the behaviour of low temperature tar under these conditions sufficient guidance might be obtained to suggest a method by which coal itself, suspended or dispersed in an oil, might be converted to hydrocarbon gases.

These experiments showed that when operating under a pressure of 200 atm. the tar absorbed some 22,000 cu.ft. of hydrogen per ton, or ten times the amount absorbed at atmospheric pressure, while 33 per cent. by weight of the tar was converted to gas of a calorific value of 900 B.Th.U. per cu.ft. No catalyst was introduced into the tar in these experiments and therefore the production of light spirit was considerably less than in processes where a suitable hydrogenation catalyst is used, but 18 per cent. of the weight of the tar was converted to oils boiling below 200° C.

The process was not, therefore, a suitable method for the complete conversion of low temperature tar to light spirit, although it may well form a valuable preliminary to catalytic hydrogenation. The yield of gas, which was the main objective, was, however, of sufficient magnitude to encourage further experiments on the direct treatment of coal suspended in tar oils. These experiments were successful in that the coal was caused to absorb 14 per cent. of its weight of hydrogen and 40 per cent. of the weight of the coal was recovered in the gaseous products,

but some difficulty was experienced in preventing the deposition of solids in the reaction coil. Eventually it became clear that in order to obtain higher yields of gas it would be necessary to operate at higher temperatures than those of 560° to 600° C. which were used in these experiments, and there was evidence that at such increased temperatures the formation of coke, although representing a very small fraction of the coal treated, might prove a serious difficulty with the type of apparatus employed.

The Lurgi Process

While this work was in progress there appeared in the German technical Press an account of some experimental work which suggested an entirely new method of attacking the problem. This was a description of the Lurgi process for the production of a gas of relatively high calorific value by the gasification, under a pressure of 20 atm., of brown coal in a current of steam and oxygen.

Brown coal is a raw material which would be considered entirely unsuitable for gas production by the usual methods of carbonization as its high oxygen content causes the gas obtained to be rich in carbon dioxide and to be of a poor quality, while the solid residue requires to be briquetted before use owing to its powdery nature. The Lurgi process made no attempt to produce a solid residue, but gasified the whole of the raw material in the generator and produced a gas of relatively high calorific value (450 B.Th.U. per cu.ft.), by causing methane to be synthesized within the generator. The chemical reactions in the lower part of the Lurgi generator were very similar to those in an ordinary producer in that the fuel is gasified by combination with oxygen and steam, but the gas was enriched by the synthesis of methane at a higher level in the fuel bed from the carbon monoxide and hydrogen produced lower down.

THE USE OF OXYGEN AND HIGH PRESSURES

It may be wondered why the announcement of the Lurgi process gave rise to so much interest. The synthesis of methane from carbon monoxide and hydrogen was not new and the possibilities of using oxygen in the gasification of coal and coke had previously been discussed by several workers, notably H. J. Hodsman and J. W. Cobb, F. E. Vandeveer and S. W. Parr, and T. C. Finlayson, and from their observations it was apparent that if oxygen could be produced at a sufficiently low price considerable advantages in the technique of gas manufacture would arise.

This new proposal may first be examined so far as it is concerned with the synthesis of methane. The synthesis of methane from carbon monoxide and hydrogen was first described by P. Sabatier, who caused the reaction to proceed at a temperature of 250° to 350° C. in the presence of a nickel catalyst. The reaction may be considered to proceed according to the equation $2CO + 2H_2 = CH_4 + CO_2$.

In 1924 the Author was privileged to present before The Institution of Gas Engineers* the results of certain work on this reaction carried out in the laboratories of the South Metropolitan Gas Company. As the result of that work it was concluded that, whether one desired to use this reaction for the production of methane from water gas, or for the removal of carbon monoxide from coal gas, the costs were likely to be excessive. There were two primary reasons for this. In the first place the catalyst was found to be very sensitive to small traces of sulphur compounds and if it was to have a life of reasonable duration, sulphur compounds must be removed completely. The second reason was the large loss of heat which occurred because the reaction is strongly exothermic and evolves large quantities of heat at a temperature too low for it to be recovered easily. In spite of these conclusions interest was not lost in the possibilities of the reaction itself, but its development could not take place until the evolution of cheap and efficient methods of sulphur removal, or the discovery of a catalyst immune to sulphur poisoning, and the appearance of an outlet for large quantities of heat at a low temperature.

The new factor which was now brought into operation to influence the synthesis was high pressure. The Lurgi generator was stated to operate at a pressure of 20 atm. and it was claimed that at this pressure reactions within the producer tended to form the heavier molecules, carbon dioxide and methane, rather than the lighter molecules, hydrogen and carbon monoxide. Such a statement is of course in conformity with the physico-chemical principles involved and it is common knowledge that small quantities of methane appear in the producer gas made from coke at atmospheric pressure, but it had never before been considered likely that the slow reactions by which methane is synthesized from carbon monoxide or from carbon dioxide and hydrogen would proceed, even under pressure, sufficiently rapidly in the absence of a catalyst to be of commercial interest. If the claims of the Lurgi Company could be substantiated by the results obtained in practice then the practicability of the synthesis of methane took on a very different aspect.

In the earlier review of the possibilities of these reactions, to which reference has already been made, one of the objections to its commercial development was the poisoning of the catalyst. In the new process no catalyst was necessary. The second objection that had been raised was the loss of the heat generated by the exothermic reactions of methane formation. In the new process these exothermic reactions took place within the generator and the heat liberated was usefully employed in distilling and preheating the fuel as it travelled towards the combustion zone, thereby supplementing the heat generated by the combustion of carbon, and reducing the amount of oxygen required.

The second feature of the process was the use of oxygen on a commercial scale. The advantages of using oxygen in the manufacture of producer gas and water gas had long been recognized and it is unnecessary to traverse again the well-trodden ground on which the arguments for its use are based. It is sufficient to say that it had been computed that it would be commercially justifiable even for existing processes to pay as much as 1s. per 1,000 cu.ft. for oxygen. Until a few years ago it did not appear that such a low price was likely to be realized, but, at about the time that a description of the Lurgi gasification process was given, there appeared also descriptions of the Linde-Fränkl process which, it was said, was producing oxygen at about 6d. per 1,000 cu.ft. This announcement obviously lent added interest to the Lurgi process.

The prospects of obtaining some important results by the application of the principles exemplified in the Lurgi process led the Joint Research Committee of the Institution and Leeds University to think that there was enough promise to justify sending a delegation to Germany to learn what it could both of the Lurgi process and of the recent developments in oxygen production. This delegation was received very kindly both by the Lurgi Company and by the Linde Company, and obtained every assistance and a considerable amount of data from these firms. With regard to the cost of oxygen production, there appeared to be no reason to doubt the statement that, in sufficiently large quantity, oxygen, of a purity of 90 per cent., can be produced at between 6d. and 8d. per 1,000 cu.ft. On a smaller scale the cost would probably be between 1s. 8d. and 2s. On the occasion of this visit there was not a commercial plant in existence operating the Lurgi process, and the experimental plant which had been used during the development of the process was dismantled. Experimental data were, however, available and, together with the information obtained in discussion with the technical officers of the Lurgi Company, indicated that a gas of 420 to 450 B.Th.U. could be produced without any technical difficulties and with a thermal efficiency of about 80 per cent. from brown coal; but the project of gasifying a bituminous coal, or a high temperature coke from a bituminous coal, in a similar generator was not regarded with favour. Later an opportunity was afforded to the representatives of the Joint Research Committee to visit a Lurgi plant actually in operation on the gasification of

* Trans. Inst. Gas Eng., 1923–24, p. 169.

brown coal, and they had no reason to question the claims as to performance and yields.

ADVANTAGES OF OPERATION AT HIGH PRESSURES

The outstanding impression which remained with those who had seen the high pressure process in operation was the great advantage that is to be gained by operating under these conditions. Gasification at 20 atm. pressure, particularly when associated with temperatures such as those existing in a producer may, at first, appear to be a bold venture, but it should be remembered that the high temperatures do not reach that part of the apparatus which is designed to withstand the pressures and that in modern steam raising practice 20 atm. is quite a moderate pressure. 300 lb. per sq.in. is a steam pressure which has been in use for many years, and modern boiler designers are becoming accustomed to thinking in terms of 1,200 to 1,800 lb. per sq.in.' Chemical synthesis today is regularly carried out in this country at 200 atm. and in France, where the Claude process finds favour, pressures of 1,000 to 3,000 atm. are used.

One may draw an inspiring analogy from the development in electricity generation and distribution in the last twenty years. At the beginning of that period some undertakings distributed energy at 550 V, and that was considered quite a dangerously high pressure; today the Grid works at a pressure of 132,000 V. The Gas Industry would not shirk the technical problems that might be involved in high pressure operation.

Most of the advantages that would be derived from operation under these pressures of several atmospheres are associated with the reduced size of plant. Perhaps this is best illustrated by referring to the size of the pipes required for transmitting the gas both on the Works and on the district. For example, from a producer which was gasifying 20 tons of lignite per day, and producing about 600,000 cu.ft. of 440 B.Th.U. gas, the internal diameter of the outlet pipe to the purifying plant was just over 2 in. After the coolers the internal diameter of the " works main " was 1½ in. Actually, the five mile long working up main leading to the town where the gas was consumed was 4 in. in internal diameter because, by making the main of this size, six hours' storage capacity was obtained. The distribution engineer will not be slow to realize what it would mean to him, particularly in rural districts, if he could rely upon a pressure of some hundreds of pounds per sq.in. at the Works without having to pay heavy compression costs.

Purification of the gas from hydrogen sulphide and the recovery of benzole are both very greatly simplified. Hydrogen sulphide is almost completely removed simply by washing with water. An interesting minor detail is the fact that the condensate from the condensers and similar pieces of apparatus need not be run into a sump and thence be pumped to the liquor tanks; under pressure one uses a steam trap and the condensate is forced by the gas pressure to its destination. Such considerations as these make the lay-out of a Works very much more simple and compact than anything which is customary in present-day Gas Works plant. Cleanliness of operation is assured by the fact that one cannot work at these high pressures unless the plant is carefully designed and kept in good condition and, in observing these essential requirements, smoke and grit are incidentally avoided.

These advantages are apparent on the surface, but there are other advantages which are not quite so obvious. First there is the fact that apparatus of the producer type may be worked at a considerably greater throughput than is permissible at atmospheric pressure. The limiting throughput of a producer or water gas generator is reached when the velocity of the blast is such that particles of the fuel in the fuel bed become disturbed. By working at a pressure of 20 atm. it is, theoretically, possible to pass 20 times as great a weight of air or steam through the generator before the same velocity is reached, although this is modified to some slight extent, so far as the stability of the fuel bed is concerned, by the increased density of the gas. It is a practical fact, however, that although the Lurgi generator inspected was working with a very light fuel containing a considerable amount of dust which would have been blown out of an ordinary producer in quantity, a throughput of over 100 lb. of dry, ash-free fuel per sq.ft. per hr. was obtained without any sign of dust in the outlet pipe.

The next advantage to be considered is not dissimilar, although it affects the chemical factors rather than the mechanical. The much lower velocities which exist with even a high throughput of fuel permit the gases to remain in the reaction zone of the generator for a greatly extended period. With a generator working at atmospheric pressure and with the velocities appropriate to that pressure many reactions become too slow at temperatures below 1,000° C. to be of practical interest. When working under pressure the time of contact is increased many times and these reactions may then have a commercial interest even at considerably lower temperatures. This fact is important, for it affects both the composition of the final gas produced and the thermal efficiency of the process.

The desirable effect of high pressures upon chemical equilibria was mentioned earlier when the Lurgi process was described, and this should be borne in mind in connexion with the longer time of contact to which reference has been made. Theoretically it should be possible to operate a water gas generator at atmospheric pressure with such an excess of steam as to obtain a high proportion of hydrogen and carbon dioxide and a small proportion of carbon monoxide in the resultant gas. In practice such a procedure would either require a moderate excess of steam and a long reaction time at a low temperature or a very large excess of steam and a moderate reaction time at a high temperature. By increasing the pressure it is possible not only to obtain a considerably extended reaction time, but also to employ an excess of steam that would be very wasteful at atmospheric pressure because of the large amount of heat that would be carried away in the exit gases as sensible and latent heat. Recovery of this heat from the steam by means of any form of heat interchange can only be practised to a limited extent at atmospheric pressure because about five-sixths of the total heat of the steam is latent heat and can only be recovered if the steam is permitted to raise five times its weight of water to the boiling temperature.

Thus, theoretically, steam can only be permitted to pass undecomposed through the fuel bed without adding to the thermal losses of the process, if the amount remaining undecomposed does not exceed one-sixth of the total steam supplied. As the pressure is increased the total heat of the steam remains approximately constant, but the amount present as latent heat becomes less and that present as sensible heat becomes greater. If a pressure of 800 lb. per sq.in. is taken, the total heat of saturated steam is 1209 B.Th.U. per lb., the sensible heat being 511 B.Th.U., and the latent heat 698 B.Th.U. One pound of steam condensing at 800 lb. pressure will thus heat 698 ÷ 511 = 1·36 lb. to the boiling temperature. Thus, regarding steam alone, it is possible to recover the heat in a quantity of undecomposed steam amounting to 74 per cent. of the total employed.

This fact is not given to suggest that one should necessarily require to operate processes in which a considerable proportion of steam is not decomposed, although it may well be that in order to produce a gas of low carbon monoxide content one might wish to do so. The real object of the example is to show how very greatly chemical and physical considerations are affected when one contemplates operation at pressures appreciably above atmospheric. More particularly would it justify, if justification were needed, the decision of the Joint Research Committee to sponsor investigations by which one might find out precisely what could be expected if use were made of the new technique in processes of gas manufacture.

PROGRESS AND PROSPECTS OF INVESTIGATIONS

At the Autumn Research Meeting of The Institution of Gas Engineers members receive a report from their re-

search chemists as to the progress of investigations during the year, and the reports which members have become accustomed to receiving are clear and orderly expositions of the work done and contain concise summaries of the new knowledge gained. It would be wrong for a research chemist to depart from such a style or to include any speculative matter in the compilation of his report, and because this opportunity is denied to him it may be helpful if, in this Paper, a review of the progress of these investigations is made from a rather more distant viewpoint and including, perhaps, some of the speculations which could not otherwise be presented.

When these investigations were first commenced it was appreciated that the Lurgi process, without modification, was not likely to be suitable for use in this country, and it was felt that a satisfactory process or processes might ultimately be built up on the basis of information obtained by studying the reactions between carbon and steam, between carbon and oxygen, and between carbon monoxide and hydrogen under pressure. The field to be covered by this work was obviously very great, and it was thought advisable to invite the co-operation of the Fuel Research Board in this investigation. The Fuel Research Board responded to the invitation, and a Joint Panel of the Joint Research Committee of The Institution of Gas Engineers and Leeds University with the Fuel Research Board was formed. Until recently the work at the Fuel Research Station has been concerned mainly with the gasification of coals, instead of coke, in water gas generators and with certain experiments on the combustion of pulverized coal in oxygen.

At the same time parallel experiments on the combustion of pulverized coal in oxygen at atmospheric pressure and on the synthesis of methane from carbon monoxide and hydrogen under high pressures were commenced by the South Metropolitan Gas Company. At Leeds Dr. F. J. Dent undertook a study of the reactions between a mixture of carbon monoxide, carbon dioxide, hydrogen and steam and coke at a high temperature and under pressures of several atmospheres, these conditions being, apparently, those existing in the upper part of a Lurgi generator.

This work was all planned on the supposition that methane was synthesized in the Lurgi generator by the reaction $2CO+2H_2=CH_4+CO_2$, and attempts to burn pulverized coal with a mixture of oxygen and steam were made in the hope that, if this could be carried out under pressure, the resultant gases would contain considerable quantities of methane. It may be said that the actual combustion of coal in oxygen at atmospheric pressure can be made to proceed quite smoothly, but the far more difficult problem of carrying out the same operation at several atmospheres pressure has not yet been tackled. In view of the promising developments on other lines it does not seem likely at present that this line of attack will be followed, but the idea in using pulverized coal was that, in this way, any carbonaceous fuel could be employed without troubling about its coking properties, volatile content or ash.

There was at this time in the Chemical Research Laboratory, Teddington, an alloy steel coil capable of withstanding a pressure of 50 atm. at 600° C. which had been used in connexion with the co-operative investigation on the hydrogenation of low temperature tar and coal. It was decided to use this coil in order to ascertain whether, when a mixture of hydrogen and carbon monoxide was heated under pressures up to 50 atm., methane was formed in a substantial quantity. These experiments were made and it was found that not only were considerable quantities of methane produced, but also a surprisingly large quantity of ethane. Now precautions had been taken to sulphide the interior of the tube before the experiments in order to prevent the metal acting as a catalyst, but in repeating the experiments in a tube lined with silica, heated even up to 800° C., it was surprising to find that very little methane was synthesized. This is a most important observation, for not only did it show that a sulphided metal could act as a catalyst under these conditions of temperature and pressure, but it also made it appear very doubtful if the methane formed in the Lurgi process really originated from the reaction between carbon monoxide and hydrogen.

Meanwhile, in the Leeds laboratory a discovery had been made which promised a much more satisfactory way of obtaining methane. As has been reported already in the 41st Report of the Joint Research Committee, the observation was made that if hydrogen were passed over low temperature coke while the temperature of the coke was being raised from 550° to 800° C. very large yields of methane were obtained *by the direct hydrogenation of the coal as it was undergoing decomposition.* The simplicity of synthesizing methane in this way and the very high yields obtainable not only made the synthesis of carbon monoxide and hydrogen appear much less attractive, but to the Author and to those who have been working with him for many years it was a discovery of the greatest importance.

It is obvious that if this reaction could be developed to be commercially practicable, it would enable gas engineers to do the very thing that they have so long desired, namely, to gasify the coal substance before it had been rendered non-reactive by being overheated in the carbonizing process. As far as the Leeds work can be interpreted at present it would appear that hydrogen reacts with the carbon of the coal at the moment when heat treatment would normally cause the carbon atoms to condense to a less reactive combination.

However important this discovery may be to the gas manufacturing processes of the future its interest is greatest to those who have been engaged for so long in a search for a "less ruthless" method of treating coal. It will further be seen that this discovery supplies a missing link in the knowledge of the effect of hydrogen upon the course of the reactions taking place during the carbonization of coal. Gaseous hydrocarbons, in the presence of hydrogen, are less prone to be decomposed to carbon and hydrogen and this fact is of commercial importance in the carburetting of water gas. Liquid hydrocarbons in primary tar tend to form methane and other hydrocarbon gases rather than carbon when they are subjected to heat treatment in the presence of hydrogen. *Now it is found that not only are the gas and tar affected in this way but also the solid residue.*

It will be observed that it is essential, if any process is to make use of this reaction, that there should be available a reasonably cheap means of obtaining supplies of hydrogen, or a gas rich in hydrogen, at a pressure of several atmospheres, and those engaged on the work would be feeling very much less optimistic about its eventual successful outcome if they had not already some evidence that such supplies would be forthcoming. The commercial sources of hydrogen are:

(*a*) By the electrolysis of water.

(*b*) By the separation from coke oven gas.

(*c*) By gasification of coke.

Except in very unusual circumstances, production of hydrogen by the electrolytic decomposition of water is too costly. Separation of hydrogen from coke oven gas is clearly not of major interest to a complete gasification process, for if this gas were available for the purpose there would be less need to conduct the gasification process, although it does suggest a possible combination with the carbonization process. Hydrogen is obtained from coke by the agency of water gas, either by causing water gas to reduce iron oxide to metallic iron which in its turn decomposes steam, or by replacing the carbon monoxide of the water gas by hydrogen through interaction with steam in the presence of a catalyst.

This latter process is the one which is most in favour today, but by none of these processes is it likely that hydrogen would be produced sufficiently cheaply for the purpose in mind. An entirely new aspect is given, however, by the possibility of producing hydrogen by the Lurgi process at a price which should be appreciably below that of hydrogen manufactured by existing processes. The experiments of the Lurgi Company have shown that if their generator

be operated with a higher proportion of steam to oxygen, and at a higher rate of gasification than is employed when a high calorific value is desired, the gas produced will contain about 80 per cent. of hydrogen. Moreover, this hydrogen will be at whatever pressure is chosen for the operation of the generator.

The compression of hydrogen generated at atmospheric pressure to a working pressure of 50 atm. is a costly matter and if carbon can be gasified by steam that could be generated at that pressure, it will be necessary to compress only the oxygen, which is of quite a small volume compared with the hydrogen which it is required to produce. For example, the complete gasification of one ton of coal would involve the production of something like 40,000 cu.ft. of hydrogen. If this were produced at atmospheric pressure by the catalytic process it would be accompanied by an equal volume of carbon dioxide and the entire 80,000 cu.ft. would need to be compressed to some 10 atm. for the removal of the carbon dioxide. With a mechanical efficiency in compression as high as 70 per cent. the power required would be about 280 H.P.H. and a further 40 H.P.H. would be necessary to compress the washed hydrogen to 50 atm., giving a total of 320 H.P.H. per ton of coal. One ton of carbon gasified in oxygen and steam should need about 10,000 cu.ft. of oxygen and should yield about 114,000 cu.ft. of hydrogen; thus, for 40,000 cu.ft. of hydrogen, only 3,500 cu.ft. of oxygen would be required. The separation of this oxygen from air would need 56 H.P.H., and its compression to 50 atm. a further 24 H.P.H., giving a total of 80 H.P.H.

Moreover, the production of hydrogen under pressure makes use of the advantages already reviewed in so far as they affect the conduct of a process in which relatively slow reactions are to take place in the presence of a large excess of steam. Also, the carbon dioxide produced at the same time as the hydrogen can be separated by washing with water under pressure.

Considerable difficulty had been anticipated in handling bituminous coals with hydrogen under pressure, but sufficient evidence has already been obtained to show that these difficulties can be avoided. So far as is revealed at the moment by existing knowledge one pictures coal being charged into a vessel where it will be treated with hydrogen under pressure in such a manner that it will produce as much rich gas as is desired, together with a considerable quantity of a primary tar. Probably half the weight of coal will disappear in this operation. The other half will be fed to a producer operating under pressure and supplied with oxygen and steam, and in this vessel it will be gasified to produce the hydrogen required for the first operation. This hydrogen will leave the generator with a considerable quantity of undecomposed steam and with an equal volume of carbon dioxide. Most of the heat from the hot gases and from the undecomposed steam can be recovered and returned to the generator as heat in the incoming steam and oxygen.

There is no reason to doubt that a thermal efficiency of something like 80 per cent. should be achieved in this part of the process, that being the efficiency found from the commercial working of a Lurgi generator without a heat interchanger, operating to produce rich gas. The rate of gasification in such a producer will probably be of the order of ten times the usual rate of gasifying coke in a producer at atmospheric pressure. The hydrogen, after removal of the carbon dioxide, would pass to the methanation process and it is of interest to note that the rate at which gas can be produced per cu.ft. of reaction space by gasifying semi-coke in hydrogen under pressure is between ten and twenty times the rate at which the same thermal quantity of gas is obtained by carbonization at high temperatures. The formation of methane by the direct combination of carbon and hydrogen is an exothermic reaction, some 8 to 9 per cent. of the potential heat of the reactants being liberated. It is expected that this heat will be sufficient to make this stage of the process thermally self-supporting and it should be possible to obtain a thermal efficiency here approaching 90 per cent.

These figures are given and must be accepted with very great reserve because they are only in part supported by experimental evidence, but they are given to show that although the operation under high pressures may require plant of different and more costly construction than is in common use, the attainment of high thermal efficiency and high throughput is very likely to compensate for any increased cost. If it were not for the risk that such figures might be taken by some to be definite results of experimental work it would be interesting to compute the probable distribution of carbon and the thermal balance of the process as it is seen today, but in order that such a misapprehension may not arise it is preferable to limit this statement, and to say only that there is nothing at all improbable in a yield from a ton of coal of 160 to 180 therms of gas having a calorific value between 500 and 560 B.Th.U., together with about 27 gal. of tar not dissimilar in composition from low temperature tar, and also such a quantity of 80 per cent. hydrogen at a pressure of some 50 atm. as would be required for the hydrogenation of the low temperature tar to motor spirit.

It may be that serious difficulties and set-backs will yet be met in the experimental work, and it would be foolish not to be prepared for such disappointments. It may even be necessary to return once again to methods using pulverized coal for producing carbon monoxide and hydrogen together with one of those as yet unknown, but certainly existing, catalysts that are not affected by sulphur, to produce methane. But, if a little quiet thought is given to the possibility of producing from one ton of coal of 300 therms something like 210 therms of gas, hydrogenatable tar and compressed hydrogen, there will be little doubt in the thinker's mind that the expenditure of a very great deal of effort and a very great deal of money is justified, and if that thinker happens to be a young technical man in the Gas Industry of 1938 he should be supremely grateful for the circumstances that have placed such tremendous opportunities before him.

If the Author were to allow members to believe that this communication represents the thoughts and work of one individual he would be leaving with them a very false impression. Prior to and during its preparation he has had the advantage of discussion with members of the technical committees of this Institution, with chemists at the University of Leeds, with members of the Fuel Research Division of the Department of Scientific and Industrial Research, and with members of the chemical staff of his Company. If he were to single out one to whom he would express his special indebtedness for the assistance rendered it is Mr. J. E. Davis. To these acknowledgments the Author would like to add his thanks to the President and Directors of his Company for permission to present this Paper.

Carbonization from a Plant Designer's Viewpoint

Communication No. 181

by

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The selection of a suitable subject for this Paper has given the Author some anxiety. It happens to be the first Paper presented by a Corporate Member of this Institution who comes from the contracting side of the Gas Industry, since the basis of membership was broadened. The Author was faced with two alternatives. Either he could present a Paper on some general subject connected with the Gas Industry, which might be regarded as being more properly the sphere of one associated with the production or utilization side, or he could present a Paper on some subject based upon his own field of work, which might be regarded as advertising. After careful consideration it was decided to present a Paper which follows the second alternative because, if those members of the Institution connected with the plant and equipment side of the Gas Industry have to remain silent on any subject upon which they have special experience, for fear of being thought to be advertising, then their contribution to the common pool of knowledge of the Industry will be of negligible importance.

The Transactions of this Institution show that many papers have been presented on the subject of carbonization. In the main these have been papers descriptive of results obtained on plants of various types. In the present contribution coal carbonization is looked at from a plant designer's viewpoint, and an attempt is made to indicate some of the many factors a plant designer must consider in the projecting and building of a modern carbonizing plant.

Coal carbonization, looked at from the viewpoint of a particular gas engineer in charge of a particular Works or Undertaking, has usually certain well-defined features—a certain type of coal must be used, a particular quality of gas must be made. But coal carbonization, looked at from the viewpoint of a plant designer, has not the same definition. Every individual project requires separate examination; generalizations are dangerous; what is right in one case may be wrong in another.

The plant designer has the opportunity of considering the applications and limitations of various methods of carbonization, because he can draw upon experience derived from plants of similar design working on many kinds of coal, producing gas of different calorific values, in different sized installations and in various countries. He is in possession of facts gathered from a large number of installations and can thus piece together the predominant influences. He is able from his experience to appreciate the importance of assessing rightly the effect of local factors when transplanting a process from one environment to another.

In addition, the plant must be modern in design. Throughout the Gas Industry today there is full appreciation of the need to be modern; the consumer expects new types of equipment at attractive prices; the method of appeal to the consumer must be up-to-date; and the gas engineer, when selecting new plant, wishes to embody the newest features in design. This highly desirable trend puts on the plant designer a responsibility and also causes him a certain amount of anxiety. To live he must be up-to-date. He must evolve improvements in plant, but he must be sound in his design. Competition decrees that he must achieve his purpose with economy. He is faced with the inevitable lapse of time between the outlining of a new idea upon paper and the realization of results on a commercial scale. This in the case of carbonizing plant may be taken to be of the order of four or five years. It is the motive of self preservation, as well as technical interest, which leads plant designers to watch and weigh all new developments in technique.

It may be worth placing on record that the present high state of efficiency of modern carbonizing plants has only been made possible by the courage and foresight of those engineers and administrators who have extended to the plant designer, in his effort to improve manufacturing methods, their co-operation, support and tolerance. More than one designer will have been encouraged by the recent words of Mr. H. Wood, of Sydney, on this matter:

> " We are apt to take new things for granted without realizing the amount of thought, time, and money that is expended in their development. These things do not just happen, they are the result of many years of hard work and many disappointments. When we fully realize this we shall be a little more tolerant and helpful when new systems do not turn out quite as expected. We must all pull together if we are prepared to accept the ' plums ' and assist the pioneers financially and by means of tolerance and helpful suggestions to make a success of any new system of carbonization."[1]

One of the functions of the plant designer is to decide for each project what is the most suitable plant—and by " suitable " is meant that offering the maximum advantages from the technical, economic and psychological points of view. The consideration of any new project for a coal carbonization plant is reviewed by a plant designer under the following broad headings, which will be dealt with *seriatim:*

Diagnosis of individual requirements.
Laboratory investigations of coal and coke.
Economic considerations.
Lay-out and design of plant.

DIAGNOSIS OF INDIVIDUAL REQUIREMENTS

The first step towards the selection of the most suitable carbonizing plant for any project is to consider the local circumstances.

The chief of these may be summarized as follows:—

Type and grade of coal to be used.
Calorific value of gas to be made.
Type of coke required.
Market for tar.
Size of installation.
Ground space available.
Local amenities.
Degree of flexibility required in operation.

Having determined which types of plant meet these individual requirements it is necessary to review their comparative performance from an economic standpoint, and this aspect of the matter is dealt with later.

The relative merits and functions of the different systems of carbonizaion are well known to gas engineers and have been dealt with in previous papers.[2] It will therefore be superfluous to discuss this matter in great detail. It may, however, be relevant to summarize the comparative attributes of the different systems.

Type and Grade of Coal to be Used

The nature of the coal to be carbonized is an important factor in the selection of the most suitable method of carbonization. In some cases there is little freedom in the choice of coal available at a particular Gas Works. Geographical position, access to waterways, and other local factors may make it economically obvious to use one type of coal. In this case it is necessary to select a plant with this type of coal in mind. In other instances there is a greater freedom in the choice of coal, and in such cases a knowledge of

the relative properties of different coals, coupled with a knowledge of the local requirements, should lead to the selection of the most suitable type of plant and the most suitable type of coal for any particular project. A Section of this Paper is devoted to the discussion of laboratory methods for the evaluation of the properties of coal in so far as they relate to carbonization.

Apart from the type of coal to be used it is also necessary to consider the grade and size of coal. Strongly-coking coals such as some of those from Durham and Somerset, particularly if they are in slack form, are more easily dealt with in static types of carbonizing plant than in continuous types, although the latter have been shown to work successfully on Durham coals. For medium- or lightly-coking coals, whether screened or unscreened, the choice of plant is not likely to be influenced by the nature of the coal except in so far as this affects the quality of the coke produced. For non-coking coals the choice of system is limited to one that does not depend for its operation upon the rigidity of the charge after carbonization. Thus, if the coal is graded, continuous vertical retorts are available and, if not, intermittent vertical chambers or inclined retorts or chambers may be preferred.

Calorific Value of Gas to be Made

The calorific value of the gas required plays a very important part in the choice of carbonizing plant. The abandonment of the Illuminating Power Standard has led to a greater tendency to supply a gas comprising a mixture of coal gas and water gas. There are two ways of doing this: by making straight gas in the carbonizing plant and mixing it with water gas made in an external generator; or by steaming the charge in the carbonizing unit. Coke ovens, horizontal retorts and inclined chambers do not lend themselves so readily to reduction in calorific value by steaming as do certain other types of plant, although some success has recently been obtained in the steaming of horizontal retorts.

Intermittent vertical chambers are suitable for a wide range of calorific value. Continuous vertical retorts are also suitable for a wide range of calorific values, although they cannot produce a gas with as high a calorific value as can intermittent vertical chambers. With certain strongly-coking coals there is difficulty in producing gas with a calorific value below 475 B.Th.U. per cu.ft. in continuous vertical retorts.

Seeing that either continuous vertical retorts or intermittent vertical chambers are usually adopted today when steaming of the charge is to be practised, it may be worth while to summarize the fundamental differences of the steaming process in the two cases.

In continuous vertical retorts the steaming of the charge is continuous and takes place whilst the coal is being carbonized. The extent of steaming possible and the effect thereof depend upon the type of coal undergoing carbonization. Over a wide range of calorific values the therms per retort per day remain constant for any particular coal irrespective of the calorific value of the gas being made. In intermittent vertical chambers the steaming of the charge takes place after carbonization of the coal is complete. The extent to which the calorific value of the gas is reduced depends upon the duration of steaming. Broadly speaking, the volume of gas made per chamber per day remains constant irrespective of calorific value. Consequently, as the calorific value of gas is reduced by steaming, the therms made per chamber per day fall.

The incidence of benzole washing has focused attention on the production of gas of high calorific value. For the production of high calorific value gas, those forms of carbonization which deliver from the carbonizing unit red-hot coke have a fundamental advantage over the systems which deliver cool coke. On the other hand, by suitable arrangements for cooling the coke with a minimum quantity of steam, it is possible in modern continuous verticals to produce gas with a calorific value as high as 550 B.Th.U. per cu.ft. from certain coals. The production of high calorific value gas in continuous verticals requires, however, special care in operation.

On the general question of calorific value of gas, and especially when making gas of high calorific value, it is sometimes not sufficiently realized that the methods practised in the purification process for the removal of hydrogen sulphide can seriously reduce the efficiency of the carbonizing plant. Too often is it found that an oxygen content of 0·9 per cent. is accepted in the gas leaving the purifiers. A reduction to 0·4 per cent. oxygen would result in an increase of 10 B.Th.U. in the calorific value of the gas.

Under average conditions on continuous vertical retorts each 0·5 per cent. of unnecessary oxygen in the final gas means a loss of 2 therms per ton. When making high calorific value gas the effect may be even greater.

Type of Coke Required

In selecting a carbonizing plant consideration must be given to the type of coke it is desired to make. Utilizing a given coal, static forms of carbonizing plant normally produce a more dense and less easily ignitable coke than do continuous vertical retorts.

When a new plant is installed, differing from its predecessor in any marked degree either in system of carbonization or in the arrangements for screening or quenching the coke, there often follows a period of temporary dissatisfaction, which passes away as the consumer gets used to the new fuel. If the aim is to develop a market for coke as a substitute for coal in the open grate, then it is generally found that the freer burning properties and easier ignitability of continuous vertical retort coke are valuable. For special grates, domestic boilers, etc. the denser cokes made in static plants are found to be equally satisfactory and may in many cases be preferred by the consumer.

It should be remembered that one of the most certain ways of eliminating coke complaints is constancy of quality. This fact is already well known to the producers of metallurgical coke. For satisfactory operation of the metallurgical processes it is essential that the coke fuel shall be constant in its properties such as ash and moisture content, size, shatter index and abradability. This has led coke oven operators to give much greater consideration to the supply of coal of constant quality to the coke ovens. In many cases this has necessitated the scientific blending of coals, involving accurate proportioning, fine crushing and intimate mixing. This technique has not yet, to the Author's knowledge, been applied in the British Gas Industry except in the case of the composite plant at the Dawsholm Gas Works[3] of the Glasgow Corporation Gas Department.

A constant quality of coke cannot be produced by the indiscriminate carbonization of coal of widely varying nature. Coke ovens, horizontal retorts or intermittent vertical chambers make it possible to carbonize a true blend in which say 80 per cent. of the coal passes through a $\frac{1}{8}$ in. sieve. With continuous vertical retorts optimum results are not obtainable when carbonizing such blends. In this case systematic mixing of the different coals received to give a constant mixture should be considered. An example of this practice is to be found in the Saltley installation of the Birmingham Gas Department where in 1926 the late Mr. John Foster, Engineer-in-Chief, provided individual storage hoppers of large capacity for the reception of different classes of coal. From these hoppers a predetermined mixture is elevated to the overhead storage hoppers above a large installation of continuous vertical retorts. It is believed that the performance as regards gas making results, constancy of coke quality, and retort life have justified this step.

Market for Tar

A carbonizing plant is not selected because of the type of tar it produces, but full consideration must be given to this question in view of the important influence of the credit for tar on the cost of gas production.

Coke ovens, horizontal retorts and intermittent vertical chambers all make an aromatic type of tar from which road tars complying with British Standard Specifications are comparatively easy to produce. Continuous vertical retorts give a greater yield of tar of a lighter and more paraffinic type. More care is required in the production of satisfactory road tars, but by suitable methods success can be attained. Tar from continuous vertical retorts

gives on distillation a higher yield of creosote than is obtained from tar produced in static types of plant.

The total credit for tar per ton of coal carbonized is the criterion upon which to assess the merits of the various methods of carbonization in this regard.

Size of Installation

The size of the installation has a considerable bearing upon the type of plant which can be considered. For example, the economics of operation of coke ovens depend to a large extent on size of plant. E. G. Stewart[4] shows that in this country a coke oven plant cannot compete with continuous vertical retorts unless its capacity exceeds 1,000 tons of coal per day.

The main systems for consideration in Great Britain today are horizontal retorts, continuous vertical retorts and intermittent vertical chambers. The effect of size of plant has a different influence on the three systems. Thus, for example, in a small installation of horizontal retorts the machinery for charging and discharging becomes a disproportionately heavy item of capital expenditure. Similarly, but to a less degree, the cost of charging and discharging apparatus becomes relatively heavy in small installations of intermittent vertical chambers. Continuous vertical retorts have the advantage that even with a small plant the charging and discharging devices of each retort are the same as for a large plant.

Ground Space Available

The ground space available at a particular Works has been in many cases the determining point in the type of plant installed. The selection of a plant capable of giving a large gas output per sq.ft. of ground space has in certain cases obviated the need for building a new manufacturing station.

This subject of comparative output per unit of ground space was dealt with by T. Hardie[5] in 1927 and subsequently by E. G. Stewart[4] in 1930. A number of new installations have been built during the past 10 years and therefore Table 1 has been prepared supplementing the

Table 1.—*Ground Space Occupied by Gas Making Plants*

Type of Installation.	Code Letter.	Total Output, Therms per Day.	Total Sq.Ft. Ground Space Occupied.	Therms per Day per Sq.Ft. Ground Space.
1	2	3	4	5
Inclined Retorts ..	A (Hardie)	22,338	19,500	1·15
Horizontal Retorts ..	B (Hardie)	34,560	23,400	1·48
Continuous Vertical Retorts	C (Stewart)	50,388	14,212	3·55
	D	46,670	13,300	3·50
	E (Stewart)	42,028	13,230	3·18
	F (Hardie)	31,200	11,520	2·71
	G	19,890	7,326	2·72
	H	5,724	2,580	2·22
	I	1,210	950	1·27
Intermittent Vertical Chambers	J	45,060	18,914	2·37
	K	34,040	14,432	2·36
	L	20,780	9,388	2·21
	M	1,920	1,830	1·05
Coke Ovens	N (Stewart)	85,200	91,800	0·93
	O	84,500	62,200	1·35

previous data. Figures are now included for intermittent vertical chambers.

This table compares the output of therms per sq.ft. of ground space in installations of different types and also in installations of one type but of different sizes. In each of the new instances given the ground space occupied is that required to house the carbonizing plant and to give necessary access all round it. Thus provision is made for retort or chamber bench, producers, waste heat boilers, quenching towers and that portion of the coal and coke handling plant within the confines of the retort house. In the case of the coke oven plant the ground space indicated is that required for the operation of the battery (providing necessary pusher ram clearance, etc.) together with the space required for a mechanical producer plant to heat the ovens.

From the table it can be seen that continuous vertical retorts offer the greatest output per unit of ground space, followed by intermittent vertical chambers, horizontal retorts, coke ovens and inclined retorts in descending order. It is of interest to note that examples D and J represent similar outputs of gas per day and therefore are a close measure of the relative output of continuous vertical retorts and intermittent vertical chambers per unit of ground space. It will be seen that for a plant making 45,000 therms intermittent vertical chambers occupy 47 per cent. more ground space.

Taking the three similar sized installations for continuous vertical retorts, intermittent vertical chambers and horizontal retorts, examples F, K and B, and assuming that the ground space occupied by the continuous vertical retort plant is expressed as 100, then the comparative figures for intermittent vertical chambers and horizontal retorts are 115 and 183 respectively.

Even for very large plants the output of coke ovens per sq.ft. of ground space is low in comparison with other types of carbonizing plant.

Local Amenities

The location of the Works may sometimes have a predominant influence upon the type of plant selected.

In certain cases it may be necessary to avoid emission of steam and smoke in the process of gas production. For such cases the continuous vertical retort appears to have the advantage by reason of the continuous coal feed and continuous extraction of cool coke. Such plants can be built to avoid all nuisance outside the retort house. Horizontal retorts and intermittent vertical chambers normally give rise to smoke when charged and to steam when the red-hot coke is quenched. In certain installations of intermittent vertical chambers the emission of smoke during charging has been reduced by the use of smoke collecting ducts. The steam evolved during coke quenching can be eliminated by the installation of dry cooling units.

More recently, processes have been developed which provide for a coke cooling chamber immediately below the carbonizing chamber and thus make it possible to discharge cool coke from a static type of vertical retort.

Degree of Flexibility Required in Operation

It is an advantage for a plant to be flexible in operation. Flexibility may be asked for in three different directions:

(i) Output per day.
(ii) Calorific value of gas made.
(iii) Type of coal which can be carbonized.

Continuous vertical retorts have considerable flexibility of output by the simple procedure of altering the rate of coke extraction and adjusting the percentage of steaming. The output from intermittent vertical chambers and horizontal retorts can be varied by altering the carbonizing cycle.

Flexibility to meet sudden demands is obtained by having a plant which can respond to change without any complicated procedure. Flexibility to meet seasonal demands is obtained by having the plant arranged in a sufficient number of individual units which can be brought into use as required.

At the present time benzole extraction provides an important means of obtaining flexibility of gas output. In normal circumstances a plant may be operated to make gas of a calorific value above that declared to allow for benzole extraction. At times of peak load the extent of benzole extraction can be adjusted and the percentage steaming increased or blue water gas added from external sources to reduce the calorific value of the gas to the declared figure.

A further method of providing for sudden changes in gas demand is to arrange for the settings to be capable of partial or complete firing by means of coal gas.

Comparative Gas Making Results of Different Systems of Carbonization

In order to compare the gas making results of different systems of carbonization it is necessary to find some com-

mon denominator. False conclusions may be drawn by comparing the results from a horizontal retort plant making 74 therms per ton of 560 B.Th.U. gas with those of a continuous vertical retort plant making 80 therms per ton of 500 B.Th.U. gas.

The index of assessment developed by S. Pexton,[6] the Hydrocarbon Enrichment Value (H.E.V.), seems to meet the need more nearly than any other formula yet proposed. The value of this method is that it expresses the result as a single number, irrespective of the calorific value of the gas being made.

Since the publication of the Pexton formula the opportunity has been taken of measuring a large number of results by this yardstick.

The hydrocarbon enrichment value varies with different coals on the same plant. Taking Durham run-of-mine coal (containing 8 per cent. combined ash and moisture) the following average results are found, the figures being similar to those suggested by Pexton:

	H.E.V.
Coke ovens and horizontal retorts	37
Intermittent vertical chambers	36
Continuous vertical retorts	35

This method of assessment of gas making results tells only a part of the whole story. Thus, if an engineer wishes to send out 475 B.Th.U. gas, it is of limited value to him to know that horizontal retorts give a higher H.E.V. than do continuous vertical retorts. To meet his requirements with horizontal retorts he would need to operate a second plant (carburetted or blue water gas), whereas continuous vertical retorts can make 475 B.Th.U. gas direct.

Further, a high H.E.V. figure is not necessarily synonymous with a cheap therm. This, however, is a matter of economics and must be discussed later.

LABORATORY INVESTIGATIONS OF COAL AND COKE

As previously mentioned the nature of the coal to be carbonized is an important factor in the selection of the most suitable system of carbonization.

Accumulated information on the properties of different coals is of inestimable value in the formulation of projects and guarantees of performance. The correlation of the results of laboratory tests with those of large-scale practice enables laboratory data to be used with confidence. This is especially helpful in the case of foreign coals since it is often difficult, if not impossible, to arrange for the shipment of sufficient material for the carrying out of bulk tests.

From the special viewpoint of the plant designer it was necessary to develop a new technique for the testing and evaluation of coals. It is felt that a survey of the methods evolved, adapted or adopted in the Woodall-Duckham Laboratories for the examination of the gas making and coking properties of coal and for the study of the behaviour of coal during carbonization may be helpful in providing a useful guide to those concerned with plant design and performance. The methods have stood the test of many years of practical application, both in connexion with Gas Works and coke oven projects, and provide a reliable small-scale means of forecasting the behaviour of a coal under a variety of carbonizing conditions, and the yields and quality of the products obtainable.

The tests described may be summarized as follows:

The crucible swelling test.
The laboratory assay of coals for carbonization purposes.
Rate-of-swelling tests.
Swelling pressure tests.
Prediction of coke quality.
Nature of ash.

The Crucible Swelling Test

It was recognized many years ago that one of the chief factors which influence the travel of the charge in a continuous vertical retort is the extent to which the coal swells during carbonization. In this type of plant the continuous extraction of coke enables fresh coal to enter, but also provides the coal in the plastic zone with every opportunity to swell. With a coal which swells strongly there is competition between the plastic coal in the retort and the coal in the feed hopper for the free space left by the extracted coke. The plastic coal, by virtue of its position of advantage, tends to win. Different conditions prevail in a static carbonizing system, in which the coal is confined within rigid walls, the effect of expansion being then merely the development of pressure on the walls of the carbonizing chamber.

It was evident that a suitable test was desirable in order that the relative swelling powers of different coals might be assessed. A simple and rapid test, which involves merely the heating of 1 g. of coal in a covered silica crucible over a Bunsen burner, was devised and was described in 1925.[7] A coke button of fairly regular shape is thus obtained, the size of the button depending on the swelling power of the coal. By means of the test it was soon possible to distinguish as many as 9 different size gradations, to which swelling numbers ranging from 1 to 9 were assigned (See Figure 1). As a result of further experience covering

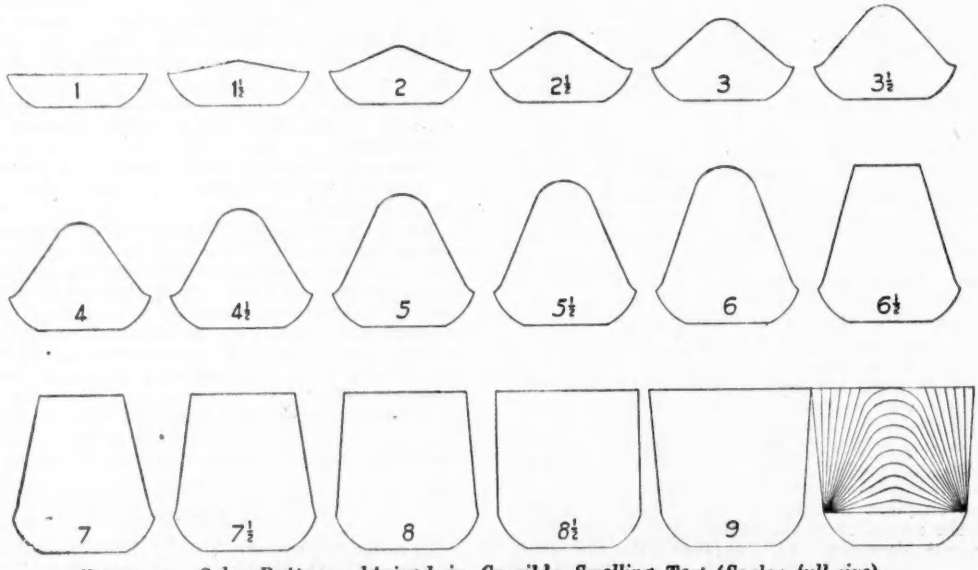

FIGURE 1.—*Coke Buttons obtained in Crucible Swelling Test (Scale: full size).*

several hundred samples of coal, it was found possible to interpolate half numbers and, subsequently, a graded series of 17 standard profiles was developed for use in the assessment of the size of the coke buttons obtained in the tests.

Regular use of this test has been made from the time of its inception and several thousand samples of coal have been examined. Its value as a guide to all who use continuous vertical retorts is commended. The test, which takes a matter of a few minutes to carry out, gives, when correlated with experience, important indications on such items as travel of coal in the retort, coke quality and amount of breeze, gas quality, and the extent to which it is desirable to mix the coal under test with other coals of known swelling number.

Quite apart from its value as a simple " tell-tale " in connexion with continuous vertical retorts, the above swelling test is a first simple guide to coke quality in blending coals for coking purposes. Broadly speaking, the lessons of this test may be summarized as follows:

For Continuous Vertical Retorts: Coals with swelling numbers ranging from 1 to 7 offer no difficulty in carbonization irrespective of the rate of heating and can be subjected to steaming as required. Coals with numbers 8 and 9 are more sensitive to rate of heating and less reactive to steaming. Coals with swelling numbers up to 3 generally produce a coke smaller in size than the original coal. As

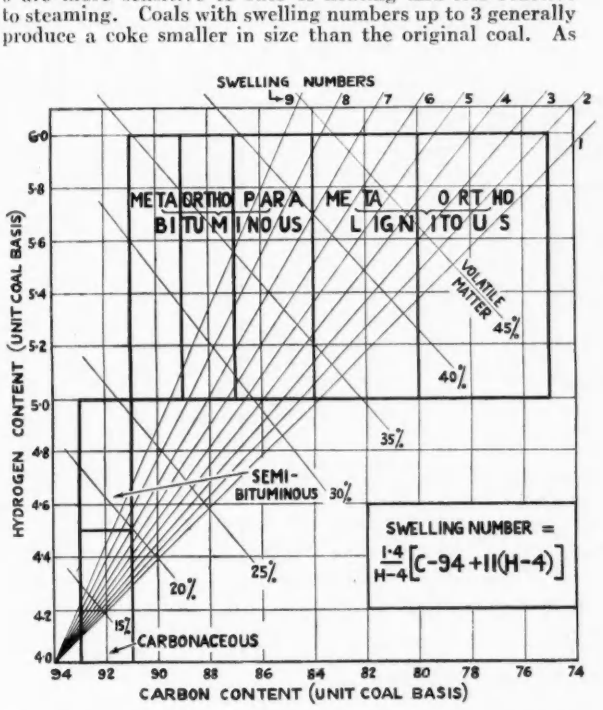

FIGURE 2.—*Mott and Spooner's Correlation of the Crucible Swelling Test.*

the swelling number rises from 3 to 9 the percentage of breeze is reduced.

For Intermittent Vertical Chambers and Coke Ovens: It is very questionable whether a coherent coke could be obtained with a coal having a swelling number less than 2 to 2½. For a satisfactory coke a swelling number of at least 4½ to 5 is desirable. No difficulty is experienced in carbonizing coals over the whole range of swelling numbers, except in the case of certain special coals which either give rise to excessive pressures on the chamber walls during carbonization or else do not ultimately contract sufficiently to permit of easy discharge. This point is referred to again later.

A panel of the British Standards Institution, appointed in 1934 with the object of framing a Standard Specification for a swelling test for coal, has recommended the adoption of the test described above. It may be mentioned that R. A. Mott and C. E. Spooner have been able to correlate the swelling number with the ultimate composition of the coal on a mineral-free basis by means of the formula:

$$\text{Swelling number} = \frac{1{\cdot}4}{H-4}\,[C - 94 + 11\,(H-4)]$$

in which C and H represent the percentage contents of carbon and hydrogen in the pure coal. When plotted on Seyler's Fuel Chart, the formula yields straight lines of equal swelling number radiating in a fan over the coal belt with their origin at the point corresponding to a carbon content of 94 per cent. and a hydrogen content of 4 per cent. (See Figure 2). It follows from the formula that the hydrogen content of a coal has a very large effect on the swelling number. Thus, in coal containing 84 per cent. of carbon, the swelling number increases from 1 to 7½ with increase in the hydrogen content from 5 to 5¾ per cent. With a higher content of carbon the effect of variation in the hydrogen content is still more pronounced.

Laboratory Assay of Coals for Carbonization Purposes

Several forms of apparatus are available for the evaluation of the yields of gas, coke and by-products obtainable in the carbonization of coals. In 1924, when seeking a method which gave results sufficiently closely approaching those obtained in high-temperature carbonization practice to enable them to be used in the formulation of guarantees, it was decided to adopt the " Tube Test "[3] which had for some years been employed by the Koppers Company of America. The apparatus was capable of very rigid control, due to the employment of an electric furnace with 18 independent heating elements surrounding the tube in which the 20 g. sample of coal is carbonized. The individual elements are switched on in accordance with a definite time schedule, and delicate adjustment of the carbonizing temperature is effected by means of an iron core transformer. A tube test apparatus was installed in London in 1924 and tests were carried out on a wide variety of coals from which plant results were available. It then became necessary to establish factors correlating the assay yields with the large-scale yields. It has been found in practice that the tube test gives reliable information as to yields of coke, gas, tar, ammonia and benzole and also as to calorific value of gas.

Reference may be made to some relationships which have been established as a result of long experience with the tube test.

From a knowledge of the yields of water of decomposition, carbon dioxide and carbon monoxide, it is possible to calculate the volatile oxygen contained in these carbonization products as a percentage on the dry ash-free coal. This oxygen represents almost the whole oxygen content of the coal. It has been found that the oxygen figure closely approximates to the percentage by volume of carbon monoxide shown in the corrected analysis of the CO_2- and H_2S-free gas.

The ratio of the thermal yield of debenzolized gas, obtained in the tube test per ton of coal, to the percentage of volatile matter in the coal (*i.e.*, therms per unit of volatile matter) is an interesting one and may range, according to tests carried out, from 3·8 in the case of an anthracite containing 8 per cent. of volatile matter to about 1·4 in the case of a lignite containing 50 per cent. of volatile matter. Volatile matter, *per se*, is therefore no guide at all to the gas making quality of a coal.

The following interesting relationship for the tube test results has been established:

$$\text{Therms of debenzolized gas per ton of dry ash-free coal} = \frac{VM}{40}\,(131{\cdot}5 - VM - 2O_2),$$

in which

VM = Percentage of volatile matter in the coal.
O_2 = Percentage of oxygen (on the weight of the coal) present in the H_2O, CO_2 and CO obtained in the tube test.

} Dry ash-free basis.

The relationship holds good very closely for the Durham coals which have been examined and for many Yorkshire and Nottinghamshire coals, though the actual gas yield is a little higher than the calculated figure in the case of Scottish coals, and much higher than the calculated figure

in the case of South Wales coals containing less than 20 per cent. of volatile matter.

It will be apparent from the formula that the yield of therms of debenzolized gas in the tube test, from a coal containing 40 per cent. of volatile matter on the dry ash-free basis, will be 79·5 if the coal contains 6 per cent. of oxygen and only 67·5 therms if the coal contains 12 per cent. of oxygen. The importance of the proper appreciation of the gas-making quality of the volatile matter of the coal need be stressed no further. Figure 3 illustrates the above formula in graphical form.

An additional fact of importance is that the calorific value of gas from coals of high oxygen content and from coals of low volatile matter content is low, the highest calorific value, if cannel coals are left out of consideration, being obtained from strongly-coking coals with a volatile content in the neighbourhood of 34 per cent. on the dry ash-free basis. High calorific value in association with a high thermal yield is of importance, since it implies a high Hydrocarbon Enrichment Value and a high yield of gas of a lower calorific value when steaming is practised.

Rate-of-Swelling Tests

In the crucible swelling test already described the rate of heating of the coal is very rapid, a temperature of 800° C. being attained in 1½ min. Consequently the gas is generated in the plastic coal more rapidly than it can escape and the fused mass has every opportunity of swelling to a maximum extent. The test is not sufficiently discriminating in the case of strongly-swelling coals, though it enables such coals to be recognized.

It had been indicated in other quarters that the rate of heating is an important factor in controlling the extent to which coals swell during carbonization. It was therefore decided to investigate the effect of the rate of heating on the swelling properties of certain coals which were known to give rise to excessive swelling in the crucible test and to cause trouble in continuous vertical retorts. The coals of chief concern at the time were those from the Durham coalfields.

In the rate-of-swelling test, use is made of a method which is not altogether novel, though some difficulty was experienced in the devising of a suitable technique. The principle of this test is to heat, at a controlled rate, a constant weight of coal in a vertical silica tube forming a cylinder closed at the lower end and provided with a freely-moving piston resting upon the coal. A pointer moving over a graduated scale is attached to the piston, which projects beyond the upper end of the tube, and this enables the expansion of the coal to be followed.

In general, tests are carried out at three rates of heating, namely 1° C., 5° C., and 8° C. per minute.

Through the courtesy of the Gas Light and Coke Company, which supplied samples of a number of well-known Durham gas coals, it was possible to make a series of tests, the results of which are shown in Figure 4. These results are of considerable interest and indicate the extreme variations which have been found with coals, all of which have swelling numbers in the region of 7½ to 9, when subjected to the crucible swelling test. The results confirmed practical experience, since coal A when carbonized in continuous vertical retorts gave distinctly more difficulty than did coal B (See Figure 4).

The deduction which followed from the results of the investigation was that a slow rate of heating in the initial stages of carbonization is necessary in the case of strongly-swelling coals if operating difficulties in the treatment of these coals in vertical retorts are to be minimized. Systematic mixing of coal of type B with coal of type A might be undertaken with advantage.

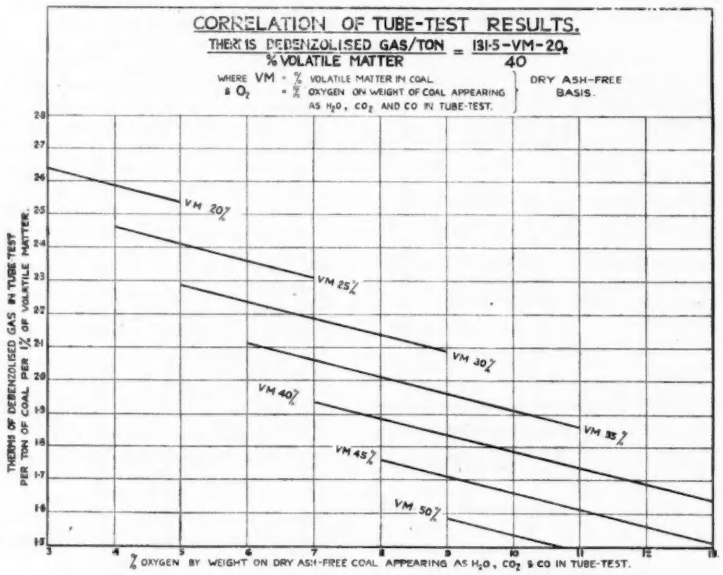
CORRELATION OF TUBE-TEST RESULTS.
THERMS DEBENZOLISED GAS/TON = 131·5 − VM − 2O2 / 40
% VOLATILE MATTER
WHERE VM = % VOLATILE MATTER IN COAL
& O2 = % OXYGEN ON WEIGHT OF COAL APPEARING AS H2O, CO2 AND CO IN TUBE-TEST.
DRY ASH-FREE BASIS.
THERMS OF DEBENZOLISED GAS IN TUBE TEST PER TON OF COAL PER ½% OF VOLATILE MATTER.
VM 20%
VM 25%
VM 30%
VM 35%
VM 40%
VM 45%
VM 50%
% OXYGEN BY WEIGHT ON DRY ASH-FREE COAL APPEARING AS H2O, CO2 & CO IN TUBE-TEST.

FIGURE 3.—*Tube Test Correlation—Relation of Therms per Unit Volatile Matter and Oxygen Content.*

Swelling Pressure Tests

During static carbonization, certain coals by swelling develop pressures sufficiently great to cause damage to the walls of the ovens or chambers. This effect is frequently, although not always, associated with failure of the coke to shrink sufficiently, when fully carbonized, to ensure free discharge.

Coals of this class usually contain less than 30 per cent. of volatile matter and are seldom used as gas coals. They are, however, frequently employed for coke production and means are required to detect them so that suitable precautions may be taken to render them harmless. Two forms of apparatus are available for the study of the pressure-developing characteristics of coal. In one form[9] the coal is carbonized under a definite pressure and the expansion of the coal is recorded. In the other form[10] of apparatus the coal is carbonized under conditions of constant volume and the pressure developed is recorded. An apparatus of

the latter type has been of considerable service in connexion with the selection of suitable safe blends of coals for coking installations.

Prediction of Coke Quality

Laboratory tests do not in themselves suffice to enable a final opinion to be expressed as to the quality of the coke obtainable from a particular coal, and must be supplemented by box tests or by tests in a miniature or full-sized oven. Laboratory work does, however, simplify the large-scale investigation very considerably, since it enables an approximate idea to be obtained either of the optimum blending proportions or of the most suitable carbonizing procedure. The large-scale work can then be confined to a few confirmatory trials, with resultant saving in time and cost.

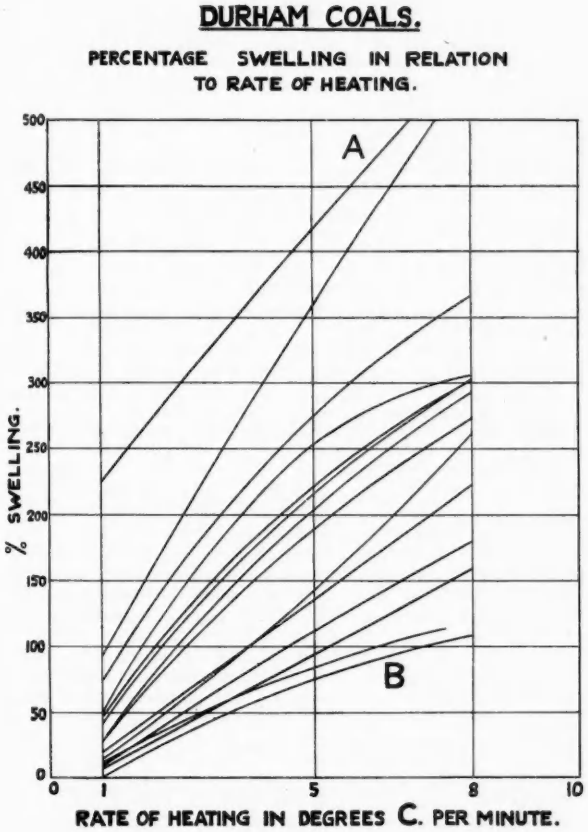

Figure 4.—*Rate-of-swelling Tests on Various Durham Gas Coals.*

In this connexion mention may be made of a test wherein a sufficiently large sample of coke is made to provide information as to the extent to which the coal particles have become bonded together, the hardness and structure of the coke, the liability to longitudinal and cross fractures, and the necessity or otherwise for the addition of a blending agent. This consists of what is termed the muffle test, in which 250 g. of coal are carbonized in a small D-shaped muffle. In such tests it is desirable to control the moisture content, grading, and bulk density of the coal, and it is also useful to adopt a variety of heating schedules, ranging from the quick heating secured by the introduction of the muffle directly into a furnace at 900° C. to the slow heating obtained by starting with a cold furnace and heating it at a definite rate.

The Nature of Ash as Affecting Producer Operation and Retort Life

The ash present in coal is a nuisance not only as regards producer operation and retort life, but also to the user of the coke derived from the coal. Its drawbacks are nowadays becoming still more evident in view of the extended use of breeze-burning producers, since breeze is usually richer in ash than is the large coke, and its use results in more dust being carried into the settings.

Unfortunately, gas engineers are often unable to purchase coals with an ash content as low as they would desire, and, equally, they are unable to stipulate that the ash must have a high fusion point.

The importance of ash in connexion with retort life is especially evident when steaming is practised, since the ash is then liberated in considerable quantity, and, if it is reactive in nature and has a low melting point, attack of the retort walls is liable to occur. The presence of sodium chloride in the coal is not as serious as it was in the days when firebrick retorts were more in use, since silica bricks are relatively immune from attack by this salt. On the other hand, if sodium chloride remains in the producer coke, troubles may arise in the combustion flues. An example of this has been given by E. F. Keable.[11]

In the producer the presence of fused ash increases the labour of cleaning the fires and leads to attack of the producer walls. Depending on its fusibility, any fuel ash carried into the setting by the producer gas will be present in the combustion flues either as a sintered mass or as a liquid slag. If in the form of liquid slag there will be inevitable penetration of the retort brickwork.

Determinations of the fusion characteristics and of the chemical composition of the coal ash are therefore very desirable in the case of unknown coals. The fusibility tests are carried out under reducing conditions as well as under oxidizing conditions, since the nature of the atmosphere has an important influence on the fusion temperature of ash when the content of ferruginous matter is high. It is necessary to ascertain the temperatures of initial and of complete fusion, since the fusion range may be either wide or narrow. A narrow fusion range combined with a low fusion point is especially undesirable.

ECONOMIC CONSIDERATIONS

As the result of his diagnosis of local requirements and of his laboratory investigations the plant designer is in possession of much information to guide him in the selection of the most suitable type of plant for any particular project, but before making a final recommendation it is necessary to review the economic considerations.

Factors Influencing Cost of Gas Production

It is not the function of the present Paper to review in any detail the important and fascinating subject of the comparative costs of gas production by means of various forms of carbonizing plant. Valuable practical data on this subject are to be found in R. W. Hunter's paper to The Institution of Gas Engineers.[12] The subject has also been dealt with at some length by the Author in a previous communication.[13] It may, however, be relevant to summarize in a few sentences the Author's views on this subject of cost of gas production:

(*a*) It is unsafe to generalize on the question of costs of gas production. As the result of the study of many projects it has been proved that each case demands individual calculation to determine what type of plant produces the cheapest gas in a given set of circumstances.

(*b*) When assessing the influence of various factors it is useful to have certain parity values in mind.
Thus: 25 per cent. more fuel into the producer,
75 per cent. more labour on the carbonizing plant,
25 per cent. more capital expended,
0·66d. less per gallon of tar made,
and 1s. less per ton of coke sold,
each have approximately the same quantitative effect on the cost of gas production when making

500 B.Th.U. gas in continuous vertical retorts and intermittent vertical chambers.

(*c*) The price ratio between coal and coke is the dominant influence in the variation of cost of gas production on any modern carbonizing plant. A high return for coke in comparison with the cost of coal is today the most certain road to the cheap therm.

(*d*) A high thermal yield of gas per ton of coal does not necessarily represent the lowest cost per therm.

(*e*) The economic soundness of benzole recovery can only be determined by calculation for each case. Such factors must be considered as coal quality in relation to calorific value of gas to be distributed, extent of coke market, and so on. In general, benzole recovery can best be applied in the slimming of a "fat" therm and is of little value in the case of a "lean" therm.

(*f*) In designing a carbonizing plant the Works requirements for steam should be carefully considered. In many cases a therm of steam produced by direct firing costs as much to make as a therm of gas. Hence the importance of waste heat recovery.

(*g*) The retort house cost of gas production in a modern plant does not account for more than 25 to 33 per cent. of the average selling price of gas.

(*h*) Economic stability in gas production depends upon the marketability of all the products. Care should therefore be taken to see that gas, coke and tar are each produced in a form to command good markets. An increase in the revenue from tar of 1d. per gal. is as valuable as trimming labour schedules by 60 per cent., and is much more probable of attainment.

Comparative Capital Costs of Carbonizing Plants

A factor which must be considered in comparing different types of carbonizing plant is their relative capital costs. Generalizations on capital cost may be very misleading.

Comparisons between the capital costs of two systems of carbonization are relevant only when:

(*a*) The plants are carbonizing the same type of coal and making gas of the same calorific value.

(*b*) Due allowance is made for any necessary loss of time in operation (scurfing, etc.).

(*c*) The schemes are similar in extent for each type of plant (*i.e.*, include the same items). In this connexion the designer not infrequently finds himself in the situation that the buyer, possibly fearing unduly to restrict competitive design, omits clearly to specify his requirements.

The final figure that matters is the capital cost per therm per day under normal working conditions.

The Author has previously discussed the question of capital costs of carbonizing plants in 1934.[13] The present abnormal—and it is hoped temporary—price level of engineering materials renders it difficult to furnish any useful comparative data relating to present-day prices. It is therefore proposed to assume in this Section that the 1934 prices still obtain, as by that means a more useful comparison may be made.

Table 2.—*Comparative Costs of Various Types of Carbonizing Plants (Hunter)*

Type of Plant.	Therms Made per Ton of Coal.	Capital Cost; Pounds	
		Per Ton Coal per Day.	Per Therm per Day.*
1	2	3	4
Continuous Vertical Retorts ..	80	249	3·12
Intermittent Vertical Chambers	80	262	3·28
Coke Ovens	74·5	279	3·74
Horizontal Retorts	74·5	260	3·49

* Calculated from R. W. Hunter's figures.

R. W. Hunter has given some interesting comparisons of capital costs of different types of plant, but in considering these figures it has to be remembered that the various plants are not making gas of the same calorific value.

Taking typical installations with a capacity of 15,000 therms per day net, that is after making allowance for retorts off for scurfing, the Author has previously indicated[3] comparative costs of two systems from which may be deduced the following figures:

Table 3.—*Comparative Costs of Continuous Vertical Retort and Intermittent Vertical Chamber Installations*

Type of Coal.	C.V. of Gas.	Type of Plant.	Therms per Ton.	Capital Cost; Pounds	
				Per Ton Coal per Day.	Per Therm per Day.
1	2	3	4	5	6
S. Yorks. Screened..	475	Continuous Vertical Retorts	86·0	280	3·25
S. Yorks. Screened ..	500	,,	80·0	260	3·25
S. Yorks. Screened ..	520	,,	75·6	260	3·44
Durham Run-of-Mine	500	,,	78·0	295	3·78
S. Yorks. Screened ..	475	Intermittent Vertical Chambers	87·5	346	3·96
S. Yorks. Screened ..	500	,,	82·0	308	3·76
S. Yorks. Screened ..	520	,,	78·0	281	3·60
Durham Run-of-Mine	500	,,	82·0	298	3·63

These figures are in general agreement with those published by R. W. Hunter but show the importance of indicating the conditions under which the capital cost of a plant is reckoned. It is equally important to know what the cost includes.

In the above figures the capital cost includes foundations, carbonizing plant, producers, waste heat boilers, coal and coke storage hoppers, coal and coke handling plant within the retort house, and the retort house building.

The capital cost is also considerably influenced by the size of the unit.

Effect of Changes in Coal and Gas Quality

The capital cost per therm of gas made per day is influenced in different directions by changes in coal quality or gas quality on different types of plant. This may be illustrated by two examples which apply to continuous vertical retorts and intermittent vertical chambers:

(*a*) A change-over from Yorkshire to Durham coal leads to an increase in capital cost per therm per day with continuous vertical retorts, but to a reduction with intermittent vertical chambers.

(*b*) A reduction in calorific value when carbonizing a given coal leads to no change in capital cost per therm per day with continuous vertical retorts, but to an increase with intermittent vertical chambers. The explanation in each case is simple:

(i) Continuous vertical retorts are able to carbonize a greater tonnage of Yorkshire coal than Durham coal per retort per day, probably because of the improved internal heat interchange with Yorkshire coal. On the other hand, intermittent vertical chambers can carbonize a greater charge weight of Durham coal than Yorkshire coal, due to the higher density of the former. Hence the difference in effect on capital cost.

(ii) A continuous vertical retort can make a constant number of therms per day over a wide range of calorific values; therefore a change in calorific value within that range does not influence the capital cost per therm. On the other hand, as the calorific value is reduced an intermittent vertical chamber makes less therms per day, with consequent effect on capital cost per therm.

Fuel Economy on Carbonizing Plants

On each project it is necessary to consider the best means of obtaining the greatest overall thermal efficiency in the carbonizing process. At one time there was a tendency to effect this by recovering heat from the waste gases by means of recuperators. Today there is a tendency to consider the fuel requirements of the Works as a whole and to recover heat from the waste gases in the form of steam. The efficacy of the latter method of heat recovery depends upon the demand for steam, but so long as the waste heat recovery plant does not produce more steam than the Works requires the method is economically sound. This can be shown in a simple or in a more elaborate method of computation.

It has been found in practice that a non-recuperative setting of intermittent vertical chambers or continuous vertical retorts uses about 20 per cent. more fuel than a fully recuperative setting. The waste gases from the non-recuperative settings are capable of generating about 4 lb. of steam* per lb. of dry coke charged to the producers. The waste gases from the fully recuperative settings are capable of generating about 2 lb. of steam* per lb. of dry coke charged to the producers.

If it be assumed that a recuperative setting of continuous vertical retorts has a fuel consumption of 11·25 per cent. dry coke (containing, say, 9 per cent. ash) and that the highest figure that can be expected from a coke-fired steam raising plant is 8 lb. of steam* per lb. of dry coke, the following calculation can be made:

(*a*) *Recuperative Setting*—

Dry fuel consumption	= 11·25	per cent. on weight of coal
	= 252	lb. per ton coal
Less coke equivalent of steam raised	= 63	lb.
Net fuel consumption	= 189	lb. dry coke
	= 8·4	per cent. on weight of coal

(*b*) *Non-Recuperative Setting*—

Dry fuel consumption	= 13·5	per cent. on weight of coal
	= 302	lb. per ton coal
Less coke equivalent of steam raised	= 151	lb.
Net fuel consumption	= 151	lb. dry coke
	= 6·75	per cent. on weight of coal

Thus, although the non-recuperative setting uses 20 per cent. more fuel, the net fuel consumption, allowing for steam raised, is only 80 per cent. of that of the recuperative setting. A similar result is found if the foregoing calculation is repeated for the case of intermittent vertical chambers.

This question of plant design in relation to fuel economy can be illustrated in another way by considering the case of an installation of continuous vertical retorts built in two alternative forms.

One scheme comprises non-recuperative retorts heated by step-grate producers and with waste heat recovery in the form of steam. The second scheme comprises a plant in which the most efficient form of heat recovery (apart from steam raising) is applied, namely, the regenerative principle, wherein the heat of the waste gases is imparted to the air and producer gas for heating the setting. It will be appreciated that the regenerative system involves the alternate passage, through suitable twin chambers filled with chequer bricks, of the waste gases on the one cycle and secondary air and producer gas on the reverse cycle. This method effects a higher degree of heat interchange than the continuous flow recuperator more normally employed in Gas Works. The waste gases are, however, cooled to such a degree that steam raising from them is unremunerative.

Such an installation is usually heated by clean cold producer gas made in mechanical producers. The capital cost of such a plant is higher than that of the more simple non-recuperative design, but because the producer gas is free from dust the maintenance cost of the setting is lower.

Table 4 shows the comparative costs between non-recuperative and regenerative continuous vertical retorts based on a series of assumptions which are set down in the table. It is believed that the assumptions are reasonable, but, of course, they may be varied to satisfy individual conditions.

Consideration of this table shows that, allowing for only a moderate consumption of steam on the Works per ton of coal carbonized (1,200 lb. per ton), the total fuel bill is greater with the regenerative settings than with the non-recuperative settings. It is also seen that, although the maintenance cost of the regenerative settings is assessed as only 63 per cent. of that of the non-recuperative settings, the total capital charges per working day are higher for the regenerative settings, due mainly to the large extra capital sum expended on their installation. On an installation with a capacity of 400 tons of coal per day, working 300 days per annum, the total annual sum in favour of the non-recuperative scheme is over £6,500.

Table 4.—*Comparative Costs Between Non-Recuperative and Regenerative Continuous Vertical Retorts*

Yorkshire Coal making 500 B.Th.U. Gas

Non-Recuperative Settings.		Regenerative Settings.	
Assumptions.			
Operation—		*Operation*—	
Coal throughput, tons per day	400	Coal throughput, tons per day	400
Dry fuel consumption, per cent.	13·5	Dry fuel consumption, per cent.	11
Value of dry coke, shillings per ton ..	25	Value of dry coke, shillings per ton ..	25
Steam requirements, lb. per ton of coal ..	1,200	Steam requirements, lb. per ton of coal ..	1,200
Cost of steam, pence per 1,000 lb.—		Cost of steam, pence per 1,000 lb.—	
From waste heat boilers ..	3	From direct fired boilers	18
Capital Cost—		*Capital Cost*—	
Capital cost £ per ton per day of complete carbonizing plant, including settings, producers, buildings and waste heat boilers ..	260	Capital cost, £ per ton per day of complete carbonizing plant, including retort settings, regenerators, mechanical producers and buildings ..	332
made up of—		made up of—	
(*a*) Settings and producers, per cent.	80	(*a*) Retort settings and regenerators, per cent. ..	76
(*b*) Buildings, per cent.	9	(*b*) Mechanical producers, per cent.	16
(*c*) Waste heat boilers, per cent. ..	11	(*c*) Buildings, per cent.	8
Capital Charges—		*Capital Charges*—	
Interest on capital sum, per cent.	4	Interest on capital sum, per cent.	4
Sinking Fund 20 years, per cent.	3·5	Sinking Fund 20 years, per cent.	3·5
Maintenance—		Maintenance—	
(*a*) Retort settings and producers, per cent.	say 5½	(*a*) Retort settings and regenerators, per cent.	say 3½
(*b*) Buildings, per cent.	say 2	(*b*) Mechanical producers, per cent.	say 2½
(*c*) Waste heat boilers, per cent. ..	say 2	(*c*) Buildings, per cent.	say 2
Comparative Costs per Day. (Costs of Coal and Labour assumed to be constant)			
	£ s. d.		£ s. d.
(1) Fuel bill—54 tons at 25s. per ton ..	67 10 0	(1) Fuel bill—44 tons at 25s. per ton ..	55 0 0
(2) Steam bill	6 0 0	(2) Steam bill	36 0 0
(3) Capital charges (calculated on basis of 300 working days per annum) ..	42 12 0	(3) Capital charges (calculated on basis of 300 working days per annum) ..	47 9 0
Total	£116 2 0		£138 9 0
Credit balance—	£ s. d.		
Per day	22 7 0		
For 300 days per annum	6,705 0 0		

The above calculations also serve as a guide to the effect of heating settings of any type by means of:

(i) Hot producer gas made in step-grate producers, or

(ii) Clean cold producer gas made in mechanical producers.

The hot producer gas scheme has the advantages of a

* From feed water at 60 F. to steam at approximately 120 lb. per sq.in. pressure.

high effective producer gas efficiency because advantage can be taken of the sensible heat in the gas, and a relatively cheap plant. It has the disadvantage that the maintenance cost of the setting is increased by the presence of dust in the producer gas. The cold producer gas scheme has the disadvantage that there is a lower effective producer gas efficiency (due to cleaning the gas) and that the producer gas has to be heated up in suitable recuperators or regenerators. It has the disadvantage also that the capital cost of the complete installation is higher. On the other hand clean producer gas results in a lower maintenance cost of the settings themselves.

The final test between these two methods of heating settings is the effect on the cost per therm of gas made. Such evidence as the Author has been able to collect or consider leads him to the conclusion that the procedure generally employed in British Gas Works of heating settings by hot producer gas, coupled with waste heat recovery in the form of steam, leads in British conditions to a lower cost per therm of gas made, in spite of the shorter life of the settings caused thereby. In considering the popularity of mechanical producer installations in many Continental Gas Works three local factors should be borne in mind. Firstly, labour rather than thermal considerations may in some cases be the reason for their selection; secondly, the coke to be gasified frequently has a relatively high ash content; thirdly, the practice of waste heat recovery in the form of steam has not been so widely developed there as in this country.

LAY-OUT AND DESIGN OF PLANT

General Principles of Plant Lay-out

A plant designer must be able not only to design the individual units constituting the plant but also to arrange the lay-out of the installation to the best advantage. A well-planned lay-out economizes labour and promotes efficiency.

After having selected the type of plant to be installed a number of points have to be considered.

The first step is to determine the capacity of the individual units to be employed. It is generally found that the greatest economy is attained with a plant made up of a number of the largest individual units that can be considered. The capacity of each individual unit must, of course, be related to the capacity of the complete installation. It is then necessary to decide how the individual units shall be grouped, care being taken to see that the installation is divided into a number of benches or settings, which can be operated independently to accommodate seasonal loads and repairs.

Having decided the details of the setting arrangement, consideration must then be given to the correct grouping of auxiliary plant such as producers, waste heat boilers, pumps and other mechanisms so that the arrangement is economical as regards both first cost and operating cost. The duties of each worker must be carefully considered and the equipment under his control so grouped that a minimum amount of time and effort is expended. A careful time study of each individual operation made by a worker has often been found extremely valuable in improving the design of the more complicated machinery used in connexion with coal carbonization; for example, a combined door removal, coke pushing and coal levelling machine employed on coke ovens. It should be the function of the plant designer to reduce to a minimum the manual effort of the individual workers. The ideal to be sought is that they should be process controllers rather than manual labourers. The electrical power station is nearer to this ideal than the average retort house, although modern gas plants have shown considerable advance in the direction indicated.

The importance of comfortable access to the various control platforms cannot be too highly stressed, nor too carefully considered. Ease of access for the operator ensures greater attention on his part and consequently increased efficiency of working. The point of entrance to the retort house at ground level must also be carefully chosen with regard to the disposition of the units inside. A clear walkway should be allowed both to the main stairway and to the lift, if the latter be installed, without the necessity of brushing past columns or machines.

It is also good practice to arrange wherever possible for the lift and stairways to be separated, preferably at opposite ends of the installation, so that in an emergency workers on the upper levels have a clear means of escape. Resting places for movable machines should be provided in such positions that they do not interfere with normal access platforms and walk-ways.

When laying out a plant the possibility of extension should always be kept in mind, even where this does not seem likely at the time of designing. Conditions are apt to change materially even in the course of a year. The more important of the auxiliaries can and should be placed in a position where an extension would not involve their removal.

Most Gas Works need to store coke in the open, and it is preferable to locate the retort house on the windward side of the coke store. The dust from an ill-positioned coke heap tends to make it difficult to keep the retort house clean. It is also desirable to see that no side of the retort house is blocked by adjacent buildings or walls if it can be helped, as these tend to prevent adequate light and fresh air from reaching the plant. Particularly is this harmful when the windward side of the house is so shielded.

It should also be remembered that it is false economy to cramp and overfill the side and end bays of the retort house.

Coal and Coke Handling

Most modern carbonizing plants involve the storage of large quantities of coal and coke at considerable elevations. The choice of a suitable handling plant therefore requires careful consideration. Selection can be made from a number of types, including bucket elevators, gravity bucket or lip bucket conveyors, push plate, scraper, or tray conveyors, belt conveyors, skip hoists, telphers, and cranes.

In the selection of handling plant for any particular project consideration has to be given to the quantities of materials to be handled, bearing in mind that no conveying plant operates in practice at 100 per cent. load factor and that allowance must be made for this fact. The nature of the materials must also be considered (especially from the point of view of their effect upon the cost of maintenance) as well as the desirability of reducing actual running time to the minimum to avoid unnecessary wear and tear. In designing handling plant due attention must be given to facility for examination and repair and to ensure ample lubrication of working parts and exclusion of dust therefrom. By way of illustration it may be of interest to indicate what may be termed " popular selections " when related to small, medium, and large installations of continuous vertical retorts.

Small plants usually rely upon a bucket elevator for coal, with a lift for handling the coke in skips. For medium-sized plants a combination of lip bucket conveyor and bucket elevator is a popular arrangement. This combination has the advantage that the plant can be coaled simultaneously with the removal of coke, the latter being discharged from the lip bucket conveyor at a suitable elevation prior to the feeding of the coal from the bucket elevator on to the lip bucket conveyor. This arrangement has the further advantage that it enables coke to be delivered directly into a screening plant or alternatively to overhead storage hoppers for producer fuel. Larger plants generally have the lip bucket conveyor in duplicate for standby purposes, and this provides for simultaneous coal and coke handling.

The coal breaker, if one is installed, should if possible be arranged above ground.

The mechanical unloading of railway wagons is usually worth while in any but very small installations.

Skip hoists and belt conveyors are among the more modern methods of handling coal and coke. Each can handle either with equal facility. Skip hoists can be made completely automatic when electrically operated. Belt conveyors are essentially the medium for the conveyance

of large tonnage, and are eminently suitable for the conveyance of coke. Capacities of 200 to 250 tons of coal per hr. are quite common. When the belts are used for elevating, the angle of rise is, of course, restricted and consequently space is required for their installation. Telphers and cranes are sometimes convenient for coal and coke handling. They possess the advantage of being able to put material into store and later to reclaim it.

Design of Carbonizing Unit

The culmination of all the preliminary work and thought outlined so far in this Paper is the design and construction of the carbonizing unit itself. Much could be written on this subject and on the many problems with which the plant designer is faced, but for the purposes of this Paper the Author must confine himself to some observations of a more or less general nature.

The plant designer must have:

(*a*) An understanding of the fundamentals underlying the process to be carried out.

(*b*) A knowledge of the properties and limitations of the various materials available for the construction of the plant.

(*c*) The faculty of correlating the experience available, wherever gained, in this field of work.

The conversion of a principle of carbonization into a working design is the particular function of the plant designer. While the working of, say, a continuous vertical retort is now (thanks to the British Commercial Gas Association)[16] a schoolroom topic, the designer of such a plant has to supply precise answers to many questions such as: the correct taper of the retort to ensure easy travel of coal; the disposition of suitable refractories; the provision of means for taking up the expansion of the brickwork; the bracing of the structure so that the retorts keep as nearly as possible gas-tight; the means whereby coal is fed into the retort and the means for coke extraction; the details of the combustion system to provide correct zoning of heats and easy manipulation of the controls and so on.

By thought, by calculation, by trial and often by error, the designer gradually evolves a unit which meets the exacting conditions of everyday working. The diversity of the problems confronting him is such that the teamwork of a number of specialists is necessary for their solution.

As mentioned at the beginning of this Paper, the plant designer owes a deep debt of gratitude to those who day by day use the plant he builds and who give him so freely the benefit of their experience. Much of the progress that has been made is due to the collaboration of designer and user, to their mutual advantage. By studying the little alterations in operating procedure and by noting the weak spots in construction which daily operation has revealed, the designer is gradually enabled to improve his technique.

Materials for Construction

Today the designer has available a wide range of materials for construction from which he may choose those best suited to his purpose. It is necessary that he should understand their correct application. The main components of a carbonizing plant are refractory materials, steelwork and castings. During the past few years much research work has been carried out on these materials, both to improve their quality and to make available a better knowledge of their properties. In the forefront of this work have been the various Research Associations set up under the Department of Scientific and Industrial Research.

Correlation of Experience

The keynote of a plant designer's life should be the correlation of experience. Improvement in the design of a particular type of plant may come from a study of its characteristics and defects. It may also come by the application of knowledge gained in another sphere of work. By way of illustration it may be of interest to note certain features of coke oven practice which are now engaging the attention of the Gas Industry. Amongst these are:

(*a*) The provision of coal of constant quality as a means of obtaining coke of constant quality.

(*b*) Improved methods of coke quenching, designed to maintain a uniformly low moisture content.

(*c*) Electrostatic cleaning of gas.

(*d*) The relay system of maintaining constant gas pressure in the carbonizing chambers.

In conclusion, the Author would like to place on record the view, which has been the underlying theme of this Paper, that the greatest asset a plant designer can have is the team-work of those associated with him, a practical example of which is to be found in the present contribution. He desires to acknowledge his indebtedness to those colleagues who have helped in the preparation of this Paper, and in particular to Mr. T. C. Finlayson.

APPENDIX

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Coke and Its Scientific Uses

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COKE FIRES

The importance of the open coke fire, not only from the standpoint of the Gas Industry but also from the national aspect of smoke abatement, demands that the manufacture, control of quality, and choice of suitable appliances should be described in some detail. Further, it has already been stated that, because of the large number of factors which may influence the performance of coke on the open fire, special attention must be paid to its manufacture and to the control of quality. The method of manufacture described is that used by the Gas Light and Coke Company and is given by way of example.

Manufacture of Open Fire Coke

Most of the coke sold for use in special coke grates is prepared by the carbonization of either mixed Durham or Yorkshire coals in continuous vertical retorts of narrow cross-section. Normal high temperature carbonization practice is followed; the maximum temperature of the combustion chamber is 1,400° C., 10 per cent. of steam is admitted and the throughput is adjusted so that overheating of the charge is avoided. The coke of over 2 in. mesh is passed through a cutter and the mixture of cut and uncut coke is carefully graded between 1 and 2 in. mesh. Further, to ensure that each delivery is free from any breeze which may be produced in the hoppers, a debreezing screen is fitted to the outlet of each hopper. Special importance is attached to the closeness of grading because of its influence on ignitability, and grading analyses are made from time to time to control the operation of the plant. The clean surfaces of the cut coke are also considered to assist the important factor of ignitability.

Continuous vertical retorts of narrow cross-section were chosen for the following reasons:

1. A free-burning, easily-ignited coke can be produced without loss of gaseous therm yield. Coke of an equal quality can be produced in horizontal retorts from similar coals, but this involves the loss of about 3 therms per ton of coal carbonized.
2. The narrow cross-section facilitates heat penetration to the centre of the charge, and by avoiding overheating at the retort walls the formation of graphitic carbon of poor combustibility is minimized.
3. The steaming is of advantage since
   - (*a*) The moisture content can be easily controlled to less than 5 per cent. and at the same time the coke is adequately quenched so that there is no danger of ignition in the hoppers.
   - (*b*) Fewer fractures are produced in the coke and the noise in burning, which is a disadvantage of water quenched coke, is considerably reduced.
   - (*c*) The passage of steam through the charge assists heat transmission and gives a more uniform product.

The coke produced in this way has proved popular and sales have increased, without any assistance from advertizing, from 3,000 tons in 1932, to 15,000 tons in 1935, and reached 35,000 tons in 1937. With this increase in sales it has recently become convenient in certain districts to supply open fire coke made in horizontal retorts. When this is done the carbonizing conditions have been altered so as to produce a coke of the necessary combustibility. The method of preparation of this coke is similar to that described for the open fire coke made in vertical retorts.

Control of Quality

Critical Air Blast Test

Combustibility is one of the most important factors in the control of quality and several methods have been devised by which it may be determined. All the methods are purely empirical, the value obtained depending among other things on the size of the fuel and the dimensions of the apparatus. In the Fulham Laboratory of the Gas Light and Coke Company combustibility was orginally determined by the 8 in. stove test described by H. Hollings and N. E. Siderfin.[2] In this test the fuel, graded to a standard size of $\frac{1}{2}$ to $\frac{3}{4}$ in. mesh, was burnt under controlled combustion conditions in a cylindrical water-jacketed stove 8 in. in diameter. The rate of air required to maintain combustion was a measure of the combustibility. This test has now been replaced by the more convenient Critical Air Blast (C.A.B.) test of the Northern Coke Research Committee.[8] Because of the empirical nature of the test the apparatus and procedure have been carefully standardized.

Other Tests

In addition to the C.A.B. value, tests are made on spot samples for moisture, ash, volatile matter, bulk density and grading. A simplified fire test is made on one of the approved coke grates and from this the rate of ignition and the combustibility of the coke can be ascertained.

Results of Tests

It has been found that with coke from any one retort house the C.A.B., moisture, and grading tests and the combustibility in the open grate give the best indication of quality. For coke from continuous vertical retorts of narrow cross-section satisfactory results will be obtained when the C.A.B. does not greatly exceed 0·06 cu.ft. per min., the moisture not more than 5 per cent., and the grading approximately 80 per cent. 1 to $1\frac{1}{2}$ in. and 20 per cent. $1\frac{1}{2}$ to 2 in. mesh. Some qualification of this statement is necessary to indicate that the C.A.B. figure of 0·06 cu.ft. per min. refers to coke with a bulk density of 20 to 22 lb. per cu.ft. and made from run-of-mine mixed Durham or Yorkshire coals.

Where the system of carbonization is altered it is generally necessary to adopt a different standard of C.A.B. Thus, for example, if by adopting a different system of carbonization but using the same coals the bulk density of the coke is increased to 26 lb. per cu.ft. it will be found that a lower C.A.B. value than 0·06 cu.ft. per min. is required to obtain the same open fire performance. Different standards have also to be adopted where blending of coals or the mixing of the coal with coke breeze is practised. Blending processes such as those described by H. Hollings,[9] and J. F. Shaw and J. G. King,[10] give rise to smokeless fuels which combine the desirable features of high bulk density and increased combustibility, but further experiments are necessary in order to determine more fully the economics of these processes.

In the fire test a standard volume of coke is ignited by 10 cu.ft. of gas burned at the rate of 50 cu.ft. per hr. After the gas is turned out the time taken for the fire to become red over 50 per cent. of its top surface is noted. This is called the " pull-through " time. It is possible, simply by visual observation, for different observers to agree upon the " pull-through " time to within 5 to 8 min., and this has been considered sufficiently accurate for a routine test. Where more accurate comparisons are required a Moll thermopile of special construction is used to measure the intensity of radiation at a fixed position from and above the fire. A satisfactory standard of performance in the fire test is for the " pull-through " time to be not more than 25 min. After the ignition tests have been carried out the fire is allowed to burn to half bulk. The residue is then raked free from ash and allowed to burn out without further attention. For a good quality coke the weight of unburnt fuel left in the grate should not be more than 1 lb. The value of this figure would be en-

hanced if the personal factor involved in raking the residue free from ash could be eliminated.

How nearly it is possible to control quality to these standards in a retort house carbonizing 450 tons of mixed Durham coals per day will be seen from Figure 1. In considering these results due allowance should be made for the method of sampling which has been adopted. Two spot samples of about 1 cwt. each are taken each week and tests are made on the combined sample. Variations in quality will therefore tend to be more exaggerated than would be the case if more frequent samples were taken. The tests on spot samples, however, are a very good indication of the quality of open fire coke which may reach consumers and for this reason are considered to be of more value than results which could be obtained from average samples.

The average, maximum and minimum values are given in the following table:

TABLE 1.—*Values Obtained from Tests of Coke Combustibility*

——	Test.				
	C.A.B., Cu.Ft. per Min.	Ash, Per Cent.	Moisture, Per Cent.	Volatile Matter, Per Cent. (Dry Coke).	Grate Test "Pull-Through", Min.
1	2	3	4	5	6
Average for year	0·061	7·9	1·9	1·4	18
Maximum value	0·078	9·6	6·2	2·9	35
Minimum value	0·050	6·2	*Nil*	0·6	10

Special notice should be taken of the low moisture content as indicating the control of this factor made possible by adopting modern methods of quenching.

TYPICAL COKE GRATES

There are now available a large number of different makes of coke grates and it has become general for each Gas Undertaking to recommend only those which are most suitable for the class of coke it manufactures.

[The Author here illustrated typical modern coke fires.] All provide a fuel bed depth of not less than 2½ in. at the front and about 9 in. at the back. A firebar spacing of from ½ to ¾ in. has been found to be adequate to facilitate ash removal and at the same time keep the unburnt fuel loss to less than 4 per cent. Each fire is provided with a gas ignition burner, which may be of either the atmospheric or the luminous type. The latter has an advantage in that it is more accessible and firing-back is prevented both in lighting and after the burner becomes hot. While both types give equal performance with open fire coke the experience of other Gas Undertakings shows that there may be an advantage in the atmospheric burner where cokes of high bulk density are used.

The combustion rate for any given coke depends on efficiency of ash removal, fuel bed depth, interval of refuelling, free air space in the grate, efficiency of the hit-and-miss damper in controlling the air supply below the grate, and type of firebrick used. Of these, ash removal and fuel bed depth are probably the most important. With all these variables it will be realized that it is difficult to determine the combustion rate, and the figures obtained in the laboratory are of relative value only.

It has been shown in a previous paper[1] that the chimney mainly serves the purpose of carrying away the products of combustion and its effect upon combustion rate is small in comparison with other factors.

COKE FIRES FOR SPECIAL PURPOSES

The general desire for cleaner and healthier cities has led many Councils and Local Authorities to consider coke fires for their housing schemes. Many thousands of fires have been installed in different parts of the country but there has been some dissatisfaction over the cost of gas for ignition and the time taken to ignite the coke. To overcome this, tests have recently been made with a fire which incorporates a "blower" or draw plate. In laboratory tests the use of the blower reduced the gas required for ignition from 10 to 7½ cu.ft. while the time required to produce a good fire was reduced from 45 to about 20 min. Gas consumption figures per ignition such as these are seldom obtained in the home because of a mistaken idea that the longer the gas is left burning the sooner a good fire will be obtained. These points are very well illustrated in a series of tests which have recently been made in selected artisan flats where the gas consumption per ignition and the fuel used per week were determined on fires with and without blower plates. Coke of similar quality was supplied to each flat and it was found that the gas used per ignition varied from 6 to 17 cu.ft. in the case of the fire with blower plate and from 17 to 31 cu.ft. for the fire

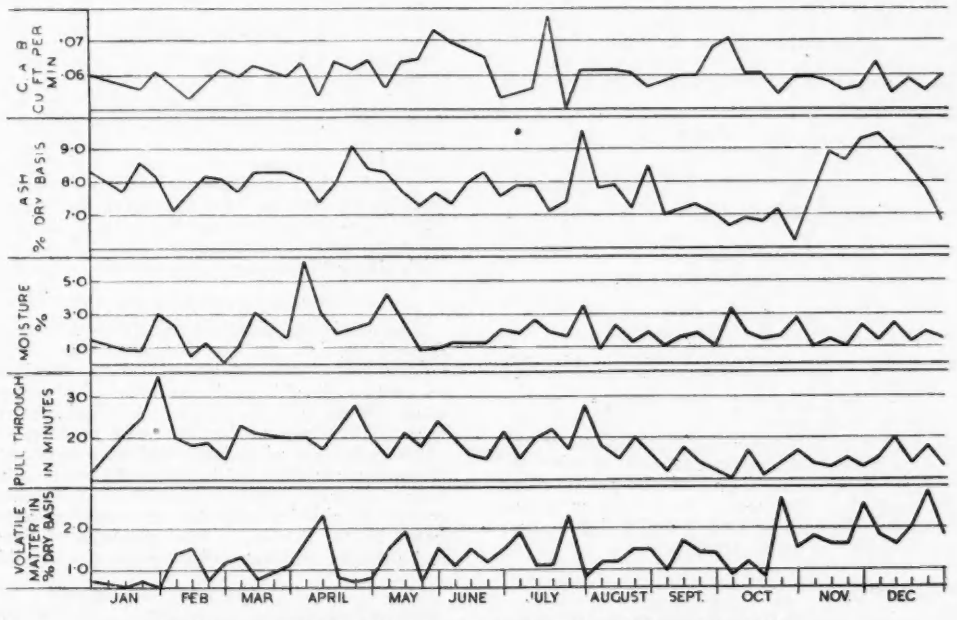

FIGURE 1.—*Weekly Analyses of Spot Samples of Open Fire Coke.*

without blower plate. The coke consumption was approximately 1 cwt. per week in each case.

Independent coke fires are more efficient than the inset type because, in addition to the radiation from the fuel, radiation and convection are obtained from the surrounding casing. This additional heat amounts to from 16 to 22 per cent. and thus gives a total efficiency of about 50 per cent.

Heating Stoves

Heating stoves, or slow combustion stoves as they are sometimes called, have been designed mainly for use with anthracite. More recently there have appeared on the market new stoves of improved design which can be operated satisfactorily on coke. With these stoves the combustion rate can be accurately and simply controlled and at low rates of combustion refuelling with coke of boiler nut size is required only once in 12 hours.

GRAVITY-FEED BOILERS FOR CENTRAL HEATING

The gravity-feed boiler was introduced in 1934 with the object of improving the performance obtained from a solid fuel fired appliance and to meet the competition of oil fuel in the central heating market.

The development since 1934 has been rapid; there are now 12 different designs, some 1,000 boilers have been sold, and there is a danger that in the face of keen competition and in order to reduce production costs the original standards of construction and design may be forgotten. The standards required are:

1. The boiler should be capable of giving its full rated output for a period of 18 hr. During this period no attention to the fuel bed should be necessary. The magazine may, however, have a fuel capacity for only 9 hr.
2. The charging doors and the magazines should be air-tight under the operating conditions for which the boiler is intended.
3. The ash-pit doors and primary air dampers should be of sound construction so that the air entering the under side of the grate can be controlled.

The choice of a gravity-feed boiler suitable for coke depends upon the following factors:

(a) Combustion Rate at Rated Output of Boiler

This varies with the size and ash content of fuel, the type of firebar, and the chimney draught. The following table gives the results of experiments and may be taken as a useful guide to the suitability of the boiler for coke of a given quality. The tests refer to a cleaning interval of 18 hr. at rated output which will give a 24-hr. operation under normal conditions.

Table 2.—*Combustion Rates when firing with Broken Coke or Boiler Nuts*

Fuel.	Grading, In.	Average Ash, Per Cent.	Combustion Rate, Lb. (Dry) per Sq.Ft. of Grate Area per Hr.	
			Grill Bars.	Water-Cooled Bars.
1	2	3	4	5
Broken coke ..	1 to 2	8·5	5	6½
Boiler nuts	¾ to 1¼	9·0	4	5

Note: (i) To obtain these rates of burning the chimney draught at the back smoke box need not be more than 0·3 in. w.g. An average figure is 0·25 in. w.g.

(ii) The grate area is measured in the plane of the grate from the commencement of the air spaces at the upper end of the grate. Any "dead plate" either in the centre or at the sides of the boiler, but not under the hopper, is included as grate area.

(b) Boiler Dimensions

To ensure an uninterrupted feed of coke on to the grate the width of the fuel throat and the angle of the grate have to be carefully chosen in relation to coke grading. The following values will be found to be satisfactory:

Table 3.—*Boiler Dimensions in Relation to Coke Grading*

Fuel.	Grading, In.	Minimum Size of Throat, In.	Normal Size of Throat, In.	Angle of Grate with Horizontal, Degrees.	Fire Bar Air Space, In.
1	2	3	4	5	6
Broken coke ..	1 to 2	9	11	30	⅜
Boiler nuts ..	¾ to 1¼	6	9	25	⅜
2 to 3 in. ..	—	—	12	30	½

The dimensions of the throat should be so chosen that the depth of the fuel bed at the lowest portion of the grate is not less than 6 in. This can be determined since it is known that the angle of repose of broken coke is of the order of 36½° and of boiler nut coke 40°. If the minimum fuel bed depth is less than 6 in. the fire has a tendency to die down in the centre and the boiler output may drop.

(c) Capacity of Hoppers

Preferably the fuel storage should be for 18 hr. at the full boiler rated output, but in no case less than for 9 hr. Since in all boilers the cleaning interval at rated output is 18 hr. the only disadvantage of the boiler with the smaller capacity is that the hoppers have to be filled more frequently.

(d) Dimensions of Combustion Space

It is desirable that combustion should be completed before the hot gases reach the secondary heating surface. Experiments with large boilers on this important factor are still in progress and have been confined to broken coke prepared in horizontal and intermittent vertical retorts. With an average fuel bed depth of 8 in. the more reactive cokes produce sufficient combustible gases to fill completely the combustion space. This results in a slightly lower thermal efficiency but complete combustion can be obtained if a combustion space is provided above the fuel level of not less than 0·1 cu.ft. per lb. of coke burnt per hr.

(e) General Finish of Boiler

Since combustion is controlled by the automatic operation of the primary, secondary, check draught and chimney dampers it is important that no air should enter the under side of the grate except through the primary air dampers. This requires that the ash-pit doors and the ash-pit itself should be reasonably air-tight.

Choice of Coke Size

Broken coke will generally be found more suitable than either coke boiler nuts or 2 to 3 in. coke. Boiler nuts contain more ash and the smaller size leads to higher fuel bed temperatures and the production of more clinker. The larger free space in the 2 to 3 in. coke enables the hot gases from the combustion space to circulate in the magazine and unless combustion is above banking rate gradual ignition of fuel up into the magazine may take place. With the modern designs of magazine doors which give an air-tight fitting no difficulties with "burning back" occur with either broken or boiler nut size coke.

Efficiency of Gravity-Feed Boilers

The efficiency obtained on different gravity-feed boilers depends mainly on the design of the secondary heating surface but is also influenced by the reactivity of the coke to carbon dioxide and the type of thermostatic control used. Thus with an average thermal efficiency of 75 per cent. this value can be decreased to 72 per cent. if a reactive coke is used or increased to 78 per cent. if a floating damper control is used in place of the open-shut type. The lower efficiency with cokes which are more reactive to carbon dioxide is due to the greater amount of combustible gases in the fire box. The presence of flame lowers the radiant heat transfer and increases the sensible heat loss.

Clinker Formation

At the maximum combustion rates the clinker formation at rated heat output amounts to 1 per cent. of the

TABLE 4.—*Heat Transfer via Primary and Secondary Heating Surfaces*

Test No.	Percentage of Rating.	Flue Gas.				Air Temp., ° F.	Flue Loss.		Fire Tubes. Secondary Heating Surface.		Primary Heating Surface Heat Transfer, Per Cent.
		CO_2, Per Cent.	O_2, Per Cent.	CO, Per Cent.	Temp., ° F.		Sensible, Per Cent.	Potential, Per Cent.	Average Gas Temp., ° F.	Heat Transfer, Per Cent.	
1	2	3	4	5	6	7	8	9	10	11	12
1	114	17·6	2·5	0·2	655	93	16·1	0·8	1,058	10·4	59·6
2	93	17·5	2·8	*Nil*	599	90	14·9	*Nil*	986	10·2	59·8
3	58	16·2	3·4	0·8	387	88	9·7	3·4	705	8·4	61·6

weight of fuel with the water-cooled grate and to 4 per cent. with the grill type firebars. The clinker is easily removed and the whole operation of cleaning the fuel bed and recharging the fuel magazines should not take longer than 30 min.

VALUE OF PRIMARY HEATING SURFACE

In a series of tests using horizontal broken coke on a boiler giving a fuel bed depth of 8 in. it was found that the heat abstracted by the primary heating surface was approximately 60 per cent. This is an important figure since it confirms that the increased efficiency of the gravity-feed over the hand-fired boiler is due to the increased radiant heat transfer in the fire box.

The results of the tests are given in Table 4.

THERMOSTATIC CONTROL EQUIPMENT

Thermostatic control equipment has come to be regarded as an essential part of the gravity-feed boiler, but its use in the wider field of hand-fired boilers has been disappointing. In new boiler installations thermostatic controls are being fitted, but because of the favourable coke markets of recent years there has been very little incentive to improve the performance of existing installations. When these favourable market conditions change and competition becomes keener it may be found advantageous to extend the use of thermostatic controls.

It should be emphasized that there is no essential difference in the application of thermostatic control to either type of boiler. The control of the rate of combustion leads in both cases to improved service and to a reduction in clinker formation, which considerably simplifies the work involved in cleaning the fuel bed. A further important advantage is that thermostatic control assists in keeping the fuel alight at slow rates of combustion and thus compensates for any changes which may take place in the combustibility of the coke. F. J. Dent and J. W. Cobb[12] have shown that all cokes are equally combustible at temperatures of over 800° C. but that the combustibility becomes of importance at temperatures represented by a dull red heat. Such conditions are frequently met in central heating and in hot water supply boilers.

The control equipment consists of two parts, the thermostat and the damper operating motor.

THERMOSTAT

The thermostat, which is placed in the boiler flow water, regulates the operation of the damper motor, and may be of the expanding rod or of the pressure bellows type, and may either make and break an electric circuit or operate a control valve.

DAMPER OPERATING MOTOR

Two general types of damper operating systems are available, (*a*) the " open-shut ", in which, as the name implies, the dampers are either full open or full shut, and (*b*) " floating " control, in which the dampers take up an intermediate position. The latter system has only recently been developed and it has already been stated that its use in place of the open-shut type will increase the boiler efficiency by about 3 units, *i.e.*, if the boiler efficiency is 75 per cent. it will be increased to 78 per cent.

The following is a selection of typical damper motor units which have been found to give satisfactory service:

(*a*) *Open-Shut Type*

The fractional horse-power electric motor, with contact breaker which stopped the driving shaft in every half-revolution, was the first unit to be evolved.[13, 14] While this is still largely used, principally because it is the cheapest unit, it is preferable to use a type which, if electrically operated, shuts the damper automatically in the event of current failure. Of these, two may be mentioned, the electro-hydraulic thrustor and the heat motor. The former is the more powerful unit, but the latter is satisfactory

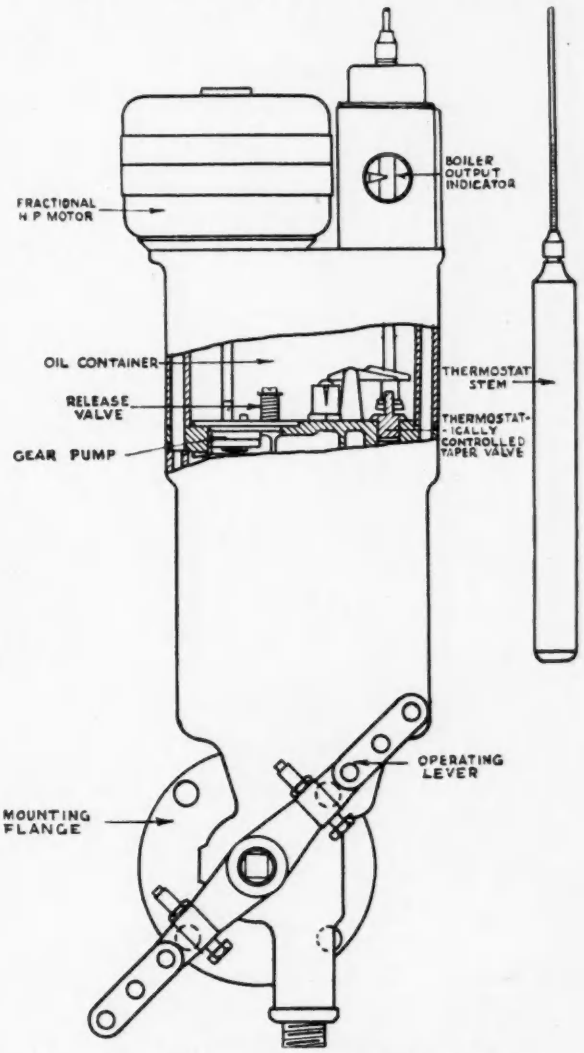

FIGURE 2.—*Inching Type Electro-Hydraulic Thrustor.*

either where the dampers are carefully balanced or where it is desired to operate only the primary air and check draught dampers. In the electro-hydraulic thrustor the impeller operated from the fractional horse-power motor causes oil to pass under the piston which in rising operates the dampers. As soon as the thermostat breaks circuit and the motor stops, the weight of the dampers

causes the piston to fall and oil passes back between the blades of the impeller.

The heat motor operates on a different principle. It consists of a heating chamber, filled with a low boiling liquid, and this is connected to a vapour pressure bellows system. On the thermostat making contact the liquid is gradually heated and in expanding passes over and compresses the vapour under the pressure bellows. When contact is broken the liquid syphons back to the heating chamber. The slowness in operation of the heat motor has not been found to be a disadvantage.

(*b*) *Floating Control Type*

In the control operated by water pressure the contraction and expansion of a bi-metal thermostat operates a leak valve which permits water either to enter or to escape from the diaphragm motor. The intermediate positions of the leak valve permit the dampers to take up any position between full open and full shut. The water pressure is regulated by a governor which also, together with the setting of the throttle valve, controls the water wastage and the rate at which the water pressure is transmitted to the diaphragm motor. A pressure of 9 to 15 lb. per sq.in. will generally be found satisfactory, and at this pressure the water wastage will seldom exceed 1 gal. per hr.

Figure 2 shows the thrustor type in which a gear wheel pump causes oil to pass into a pressure bellows chamber from which it can escape by means of a release valve. A further valve operated by the thermostat enables the damper lever to take up intermediate positions. It has been proved by experience that the oil used has an appreciable effect upon the performance of this type of thrustor and the efficiency is reduced if the viscosity falls below about 150 sec. Redwood No. 1. Since the temperature in the boiler room at the damper motor may reach 150° F. it is generally advisable to choose a non-sludging oil with a viscosity at 140° F. of about 200 sec. Redwood No. 1.

GRAVITY-FEED BOILERS OF SMALL SIZE

Typical Designs

The success of the gravity-feed boiler for central heating has led makers to design similar boilers of a small size suitable for horticultural or domestic use. Boilers of this type are particularly suitable for any purpose where continuous running for long periods without attention is required, such as the heating of small glass houses, soil warming on a limited scale, etc. There are several of these small boilers now available of which those shown in Figures 3, 4 and 5 are typical.

A boiler with central fuel feed of the type shown in Figure 3 has been used for hot water supply at the Fulham Laboratory of the Gas Light and Coke Company for a number of years, but it has not proved satisfactory because of the difficulty of removing clinker from the back of the grate. Even with a revolving grate it is impossible to clean the fuel bed thoroughly while the fire is alight. This type, therefore, cannot be recommended at present.

Figure 5 represents an interesting design. The fuel from grate level to the charging door of the hopper forms an almost vertical column, through the lower portion of which the air for combustion passes. Thus, by avoiding any sudden changes in direction, the free travel of the fuel from the hopper to the grate is facilitated. The grate is L-shaped, which gives at the further end a fuel thickness of about 2 in. and the free oxygen passing through this portion provides secondary air. Part of the primary heating surface is composed of a number of oval-shaped cast-iron water tubes between which the hot gases pass. A row of similar tubes staggered with the first forms the secondary heating surface. Inaccessibility of the tubes for cleaning is a disadvantage of this design of boiler.

The boiler shown in Figure 4 is similar in principle to that of the larger gravity-feed boilers except that it is unusual to provide a secondary heating surface. It is usual, however, to incorporate in the design some method of directing the hot gases on to the heating surface to prevent short circuiting to the flue outlet. This may in certain cases give a small amount of secondary heating surface.

Test Results on Small Gravity-Feed Boilers

In the boiler illustrated in Figure 5 the main thickness of the fuel bed is 7½ in. and this tapers to 2 in. at the lower end of the wedge-shaped fuel bed. Further, at this point there is a special slot in the fire bars to facilitate the free passage of air. Using broken coke from vertical retorts at a combustion rate of 10 lb. per sq.ft. per hr. there is a considerable amount of flame which passes through the two rows of tubes and strikes the back water way. At rated output the combustion efficiency was not very good, giving a flue gas analysis of CO_2 12·4 per cent., O_2 6·7 per cent., and CO 1·8 per cent. It is evident that there is secondary air passing through the lower end of the fuel

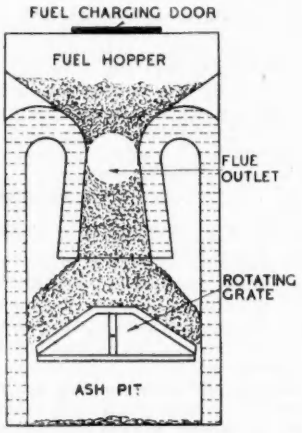

Figure 3.—*Small Gravity Feed Boiler : Central Feed.*

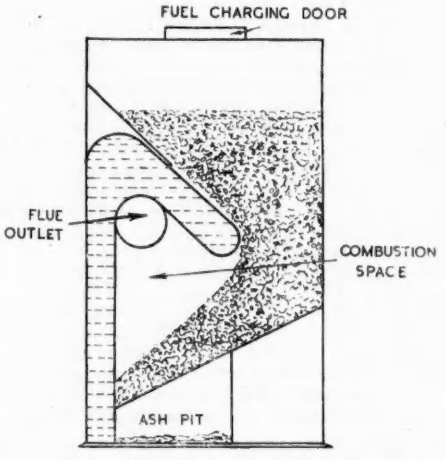

Figure 4.—*Small Gravity Feed Boiler : Side Feed.*

bed, but that this is not sufficiently mixed with the combustible gases. Improved results could no doubt be obtained by altering the position of the flue outlet and by reducing the thickness of the fuel bed to 6 in. The thermal efficiency of a boiler of this type is of the order of 60 to 65 per cent., of which some 75 per cent. is obtained from the water-backed surfaces in contact with the fuel, and the remainder from the secondary heating surface.

Combustion Space and Admission of Secondary Air

The volume of the combustion space, in relation to the size of fuel, combustion rate, fuel bed depth, and reac-

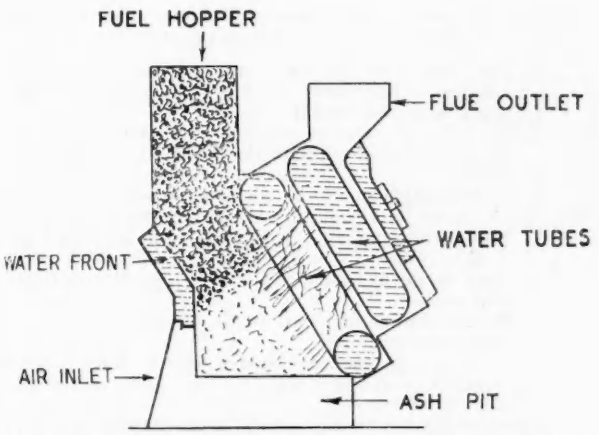

FIGURE 5.—*Small Gravity-Feed Boiler with Secondary Heating Surface.*

tivity of the coke to carbon dioxide, is one of the most important factors in boiler design. On this factor and on the addition of secondary air in such a way that it mixes intimately with the combustible gases depend the combustion efficiency and the heat release in the fire pot.

Tests have been made on two boilers of the type illustrated in Figure 4, and these indicate that

(*a*) The combustion space above the fuel should be, for a 6 in. fuel bed of coke boiler nuts, approximately 0·1 cu.ft. per lb. of fuel burnt per hr.;

(*b*) Reducing the thickness of the fuel bed to about 3 in. at the lower end of the grate will generally be found a convenient method of supplying secondary air; and

(*c*) Introduction of secondary air through a hit-and-miss damper placed above the fuel does not improve combustion, but causes a reduction in thermal efficiency.

The first boiler tested of the type shown in Figure 4 had a combustion space of 0·056 cu.ft. per lb. per hr. and the depth of the fuel bed was 8 in. No secondary air was admitted above the fuel bed and the waste gas analysis gave CO_2 13·8 per cent., O_2 3·2 per cent., and CO 4·0 per cent. By reducing the depth of the fuel bed to 6 in. the percentage of combustible gases was reduced and at the same time the volume of the combustion space was increased to 0·082 cu.ft. per lb. per hr. No secondary air was admitted above the fuel bed, but the reduced thickness of the fuel bed permitted sufficient free oxygen to pass so that the waste gas analysis was CO_2 10·0 per cent., O_2 9·3 per cent., and CO 0·5 per cent.

The second boiler to be tested of the type illustrated in Figure 4 was supplied with a hit-and-miss secondary air damper. It was found to give a thermal efficiency of 53 per cent. with the air slide sealed and 48 per cent. with the air slide open. Results of a similar order are quoted by J. Blizard and his co-workers[15, 16] in tests which were made on an American dome-topped domestic boiler.

DOMESTIC BOILERS

Much of the success which has attended the use of coke in the home may be attributed to the cleanliness and ease of operation of the domestic coke boiler. Consumers with coke boilers have become familiar with the advantages of coke and have been more willing to extend their use of coke to the open fire. In the Gas Industry the experience gained in the preparation of cokes suitable for the small fuel pot size of domestic boiler has been of considerable assistance in the choice of cokes for coke fires and heating stoves. Attention was also directed to the importance of fuel size in relation to the size of the appliance, and this has led to improvements in and increased efficiency of coke grading plant.[17]

The popularity of the domestic boiler and its increased use in houses on large building estates have led to increased competition and, in order to reduce costs, boilers with a smaller and smaller fuel capacity have been produced. The saving due to the smaller weight of metal in the boiler amounted to a few pence and only became a factor in the larger contracts. Further, there was a danger that costs might next be reduced by paying less attention to the finish of the boiler, such as the fit of ash-pit dampers and front fire doors, with a consequent loss in efficiency of the appliance. W. L. Boon[18] has already called attention to this problem and has described the steps taken to solve it by the London and Counties Coke Association.

STANDARD SPECIFICATIONS

Since 1935 a British Standard Specification[1] for Domestic Hot Water Supply Boilers Burning Solid Fuel (No. 758—Parts 1 and 2—1937), which is based largely on the Coke Specification described by W. L. Boon,[18] has been published. Wide publicity has been given to this Specification and it is hoped that all boiler makers will follow the lead of the larger manufacturers and make only those boilers which conform to the standard required. The difficulties experienced with domestic boilers have been described at some length since they illustrate the need for the control of all coke burning appliances.

The above-mentioned British Standard Specification deals with boilers having a heating surface of 2 to 5 sq.ft. The fuel capacity, rating, heating surface, fire grate, air space and area of free air space on fire grate, dampers, air control and ash-pit volume are specified, while recommendations are made with regard to installation requirements and fuel storage accommodation. It will be realized that simple measurements suffice to determine whether or not the boiler conforms with the Specification and a test is not obligatory. All boilers should, however, be able to give their rated output and pass an endurance test. The method of testing is described in Part 2 of the Specification.

The Domestic Hot Water Supply Boilers Committee of the British Standards Institution had considerable difficulty in deciding the rating, and the reasons for the values given may be of interest. It was agreed that only the heating surface above grate level should count as effective surface and that the charging and cleaning interval and the chimney draught available had a greater effect upon the heat output for any given fuel than the shape and disposition of the water-backed surface. Further, the Specification applies to coke, anthracite, semi-coke and steam coals and it was recognized that the performance of the boiler would depend on the properties of the fuel used.

Where the boiler is intended to be operated at a steady load for long periods a low combustion rate and long cleaning interval are desirable. On the other hand, where a short period of high output followed by a long banking period is required, such as in domestic hot water supply, a high combustion rate at rated output is advantageous so that overheating is avoided when the fire is banked. The rating value was therefore linked with the charging interval as follows:

TABLE 5.—*Relation between Rating Value and Charging Interval*

Domestic Boilers for	Rating Value.	
	Open Boilers, *i.e.*, Boilers having no Water Way across the Front. B.Th.U. per sq.ft. per hr.	Closed Boilers, *i.e.*, Boilers with Water Way across the Front. B.Th.U. per sq.ft. per hr.
1	2	3
Continuous hot water supply (charging at intervals of not less than 4 hr.)	6,000	6,000
Hot water supply for short periods of high output (charging at intervals not exceeding 2 hr.)	10,000	11,000

The work of the Committee is now being extended to cover the construction of domestic boilers.

COKE FOR DOMESTIC BOILERS

The various factors which influence the performance of coke in small domestic boilers are now well known and

several papers have been published showing the importance of combustibility, bulk density, fuel size, total ash content, ash volume and moisture content. It has been emphasized that flexibility under banked conditions of firing is of first importance in the selection of a coke for the domestic boiler. In the Gas Light and Coke Company the standard required is that the C.A.B. value should not exceed 0·07 cu.ft. per min. Cokes of low bulk density are graded between $\frac{5}{8}$ and $1\frac{1}{4}$ in. mesh, while coke from intermittent vertical retorts has been found to give more satisfactory results if the upper limit is reduced to $1\frac{1}{8}$ in. mesh. The

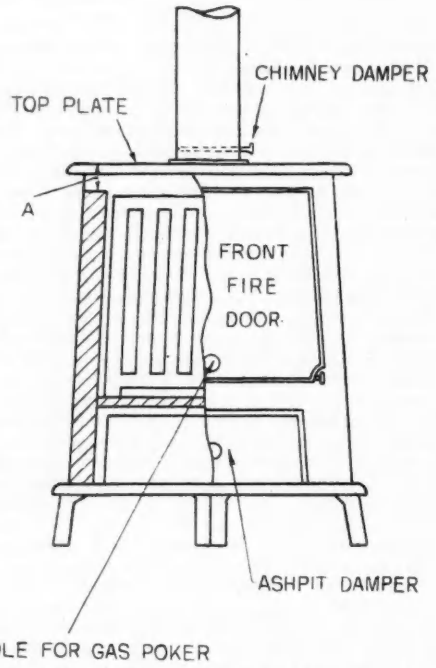

FIGURE 6.—*Small Horseshoe Type Domestic Boiler.*

banking rate on the minimum size boiler of such a coke will be found to vary between 0·4 and 0·7 lb. per hr.

INFLUENCE OF DESIGN ON PERFORMANCE OF DOMESTIC BOILERS

During the last few years, in connexion with the above-mentioned British Standard Specification and on behalf of the London and Counties Coke Association, tests have been made on a large number of different domestic boilers. From the data on open-fronted domestic boilers, as illustrated in Figure 6, it has been found that:—

1. The shape of the fuel pot, whether rectangular, square or horseshoe, has little effect upon the efficiency at rated output;
2. The efficiency can be reduced by as much as 8 units if the front fire door does not fit closely to its frame;
3. The top plate should be constructed so that the space A is not less than $1\frac{3}{8}$ in., and provision should be made in order that this plate can be sealed with boiler cement. Air inleakage at this point in one case made it difficult to obtain the rated output of the boiler;
4. The maximum fuel bed depth should preferably not exceed 14 in.;
5. By projecting the back water way to form a water bridge a slight increase of 1 to 2 units in efficiency can be obtained;
6. Secondary air inlets placed immediately under the top plate produce a lowering of the efficiency and do not improve combustion.

Table 6 shows the results of some of the tests, and it will be noted that most manufacturers favour the horseshoe design and that the cross-sectional dimensions vary only slightly. A greater difference occurs in the height of the top plate from the grate, which varies from $10\frac{3}{4}$ in. in boiler No. 9 to $14\frac{1}{2}$ in. in boilers Nos. 1 and 4. Only two of the boilers tested were fitted with secondary air slides, and these were sealed up during the test.

With regard to the fit of the front fire door, boiler No. 8 was very good. The door was strongly made and had been machined so that little inleakage of air took place. Further, the box construction of the door ensured that even after the overload test no sign of warping occurred. The door originally supplied with boiler No. 9 was of poor construction and in expanding during the test at rated output it allowed cold air to pass over the water way, thus reducing the efficiency. A slight alteration to the fire door increased the efficiency from 38 to 44·6 per cent.

INFLUENCE OF FUEL SIZE ON THERMAL EFFICIENCY

Experiments on a closed circular boiler having a mean diameter of $11\frac{1}{4}$ in. and a height to the top water way of 15 in. have shown that the thermal efficiency is increased from 50 to 60 per cent. by substituting broken coke for coke boiler nuts. This increase may be attributed to the more open structure of the broken coke, which permits the radiant heat from a larger area to reach the water-backed surface.

Banking tests of 9 hr. duration were made, and it was found that, using open fire coke, the primary air damper could be opened between the limits of $1\frac{1}{2}$ to $3\frac{7}{8}$ in. without the fire going out. This implies that an opening

TABLE 6.—*Data regarding Open-Type Domestic Boilers*

	Boiler Number and Shape.								
	1	2	3	4	5	6	7	8	9
	Square.	Square.	Rectangular.	Horseshoe.	Horseshoe.	Horseshoe.	Horseshoe.	Horseshoe.	Horseshoe.
Fuel Pot—									
Width at front, in.	$7\frac{1}{2}$	$8\frac{5}{8}$	$7\frac{3}{4}$	$8\frac{3}{8}$	$8\frac{3}{8}$	$8\frac{3}{8}$	$7\frac{5}{8}$	$9\frac{1}{2}$	9
Average width, in.	$7\frac{1}{2}$	$8\frac{3}{4}$	$7\frac{3}{8}$						
Width at mean position, front to back, in.	$7\frac{1}{2}$	$8\frac{3}{4}$	$7\frac{3}{8}$				$7\frac{3}{8}$	8	
Distance, front to back, in.	$9\frac{3}{4}$ / $4\frac{1}{4}$*	10	$9\frac{3}{8}$	$8\frac{3}{8}$	9	$9\frac{1}{4}$	$9\frac{1}{4}$	$9\frac{3}{4}$	$10\frac{1}{2}$
Height: grate to water way top, in.	$11\frac{1}{2}$	$9\frac{3}{4}$	$10\frac{1}{4}$	$12\frac{1}{4}$	$11\frac{1}{4}$	$10\frac{7}{16}$	$10\frac{1}{2}$	$10\frac{7}{8}$	$9\frac{1}{4}$
Height: grate to underside of top plate, in.	$14\frac{1}{2}$	$11\frac{1}{4}$	$12\frac{1}{4}$	$14\frac{1}{4}$	13	$12\frac{7}{16}$	$12\frac{1}{8}$	$12\frac{3}{4}$	$10\frac{3}{4}$
Distance A, in.	$2\frac{3}{8}$	$1\frac{1}{2}$	2	2	$1\frac{3}{4}$	$1\frac{3}{8}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{1}{2}$
Heating surface, sq.ft.	2·44	2·25	2·3	2·1	2·1	2·01	2·17	2·0	2·07
Rated output: B.Th.U. per hr.	24,500	22,500	22,500	20,000	20,000	20,000	21,500	20,000	20,500
Test Results—									
Average output: B.Th.U. per hr.	24,955	23,069	21,319	20,595	20,324	20,409	20,379	20,410	21,376
Efficiency ("fuel burnt" basis)	49·7	44·6	47·6	47·1	48·6	46·9	47·0	50·7	44·6

* This boiler has a projecting back water way and the small dimension is to the point of the water way.

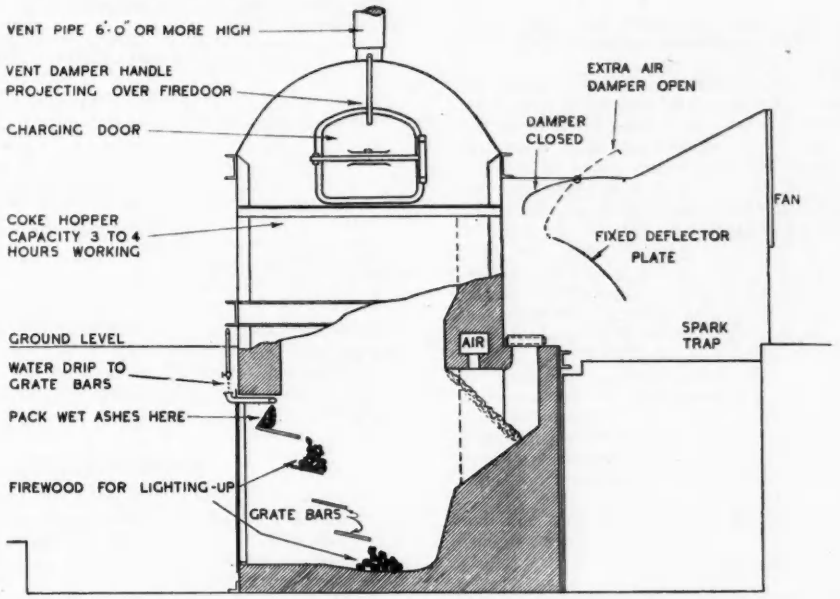

FIGURE 7.—*Semi-Producer Furnace for drying purposes.*

of less than 1½ in. admits insufficient air and the fire becomes extinguished, while an opening of more than 3⅞ in. admits too much air and the fire burns out. As the fuel pot size becomes smaller it is increasingly difficult to keep either broken coke or open fire coke alight under slow combustion conditions. The limit is reached at a fuel capacity of 0·6 cu.ft.; below this limit coke boiler nuts should be used, while above it broken coke or open fire coke may be used with advantage.

SEMI-PRODUCER FURNACE

This furnace was designed by A. C. Hutt, of the London and Counties Coke Association, and in the first instance was used in connexion with grass-drying, where waste gas at a reasonably constant temperature of about 270° F. was required. The older type of hand-fired furnace was unsatisfactory

(*a*) because the combustion rate was too high and difficulties were experienced with clinker formation; and

(*b*) because of the difficulty of maintaining a constant temperature with hand-firing, even when twin furnaces were used.

The higher thermal efficiency of the semi-producer, together with the fuel storage capacity of 3 to 4 hours and the constant waste gas temperature, have combined to reduce the costs of grass-drying so materially as to make it a commercial success.

DESCRIPTION OF SEMI-PRODUCER

The furnace illustrated in Figure 7 consists of a rectangular brick container, the upper portion of which is used for fuel storage, while the active fuel bed, 2½ ft. in thickness, extends across the lower part from a step grate to a series of brick gas ports. The main points of difference between this and the usual type of Gas Works producer are, firstly, that the fuel bed is thinner, so that the percentage of combustible gas issuing from the coke is less, and, secondly, rectangular gas ports are provided in place of a brick arch. These factors, together with the introduction of secondary air at each of the gas ports, ensure that the combustible gases are completely burnt soon after they leave the fuel bed and that a long flame extending into the spark trap is prevented. Good quality firebricks are used to line the hot fuel zone and extend to a point 12 in. above the top bar of the step grate. Above this point and for the brick arch ordinary quality firebricks are used. A vent pipe is provided through the brick arch into the hopper and the handle of the vent pipe valve is arranged so that it extends over the charging door. Thus, before the charging door can be opened the combustible gases in the hopper are vented to atmosphere and flaming at the door is prevented. The vent pipe is also used when the furnace is shut down for the night. The procedure adopted will be described later.

Water at a controlled rate is distributed over the top step of the grate. The minimum quantity of water is used so that the water vapour in the waste gases is kept as low as possible while at the same time it is large enough to keep the fuel bed cool and prevent excessive clinker formation.

A water spray pipe is fitted through the top of the hopper so that the fire can be damped down before banking. The use of this spray has considerably reduced the banking consumption of coke and thus lowered the overall fuel costs.

Table 7 gives the consumption of ungraded coke and the water feed required for various sizes of the furnace.

OPERATION OF SEMI-PRODUCER

The following method of operation was evolved from

TABLE 7.—*Fuel Consumptions Banked and Water Feed for various Sizes of Furnaces*

1	2	3	4	5	6	7
Rated coke consumption, cwt. per hr. (max.)	1½	1¾	2	2½	2½	3
Inside width of furnace, ft.	3	3½	4	4½	5	6
Water feed to grate bars, gal. per hr.	9	10½	12	7 each side	8 each side	9 each side
Water to quench fire for banking, gal.	10 to 12	12 to 14	13 to 16	15 to 18	16 to 20	19 to 24
Fuel consumption : 8 to 12 hr. banking period, cwt.	1	1¼	1½	1½	1½	1½
Fuel consumption, banked during week-end, cwt.	2½ to 3	2½ to 3½	3 to 4	3 to 4½	3½ to 5	4½ to 6

tests made on the first furnace erected for test purposes at the Fulham Laboratory of the Gas Light and Coke Company and from subsequent experience on drying plants in different parts of the country.

In lighting up from cold, dry wood and oily waste are placed on the floor of the furnace, and ungraded coke from which the breeze has been removed is then filled in to the level of the third step. More oily waste and wood are laid along the third step and the furnace filled with coke. The kindling material at the third step spreads the fire over the whole of the grate very much more quickly than is possible if the kindling material is only on the floor of the furnace. The oily waste is then lit and the fan, which drives the hot gases to the drying trays, is started.

At this stage it is usual to regulate the opening of the secondary air damper so that the draught through the fire is not excessive. In the case of grass-drying plants the temperature of the waste gases is up to 270° F. and drying can be commenced in 40 min. from lighting. As soon as the fire is well alight water is turned on to the top step of the grate and the portion of hot fuel above the top plate is "breezed-up", so as to restrict the air supply and prevent damage to the metal plate which supports the brickwork. It has been found advantageous on some plants to use breeze on all the plates.

Where drying is carried out from day to day the fire can be banked and drying can be commenced next morning within 5 min. of starting the fan.

Composition and Temperature of Gases from Furnace

On the original furnace, 3 ft. in width, erected at Fulham, three gas ports 14 in. × 8 in. were provided, while secondary air was admitted at the top of each of the ports. Preliminary experiments indicated that these ports were too wide and the resulting flame passed too far into the spark trap. The gas ports were therefore altered to give 6 ports 12 in. × 3 in. With these ports and a water rate of 7 gal. per hr. the composition of the gases at the gas ports was CO_2 6·1 per cent., O_2 0·3 per cent., H_2 11·9 per cent., CO 26·7 per cent., and N_2 55·0 per cent. The temperature of the gases was 900 to 940° C.

It will be realized that the temperature of the gases passing to the fan depends upon the opening of the secondary air damper. When this is opened more cold diluting air is allowed to mix with the hot furnace gases. At the same time the draught through the fuel bed is reduced so that the combustion rate falls and the volume of hot gases becomes less.

Method of Shutting Down

Much of the preliminary work on the first producer was concerned with the problem of finding a quick method of shutting down the furnace, for example, for meal intervals, fan breakdown, etc. The following method was evolved:

1. The cover door (not shown in Figure 7) is placed over the front of the furnace.
2. The damper tile is placed over the gas outlet.
3. The secondary air inlets at the side of the furnace which lead to the gas ports are closed.
4. The fan is stopped.
5. It is generally desirable to open the vent damper for a few minutes, but this should not be left open continuously as otherwise the draught up through the hopper will cause wastage of fuel.
6. The water rate to the step grate is reduced to about 30 drops per min.

If these instructions are followed the time taken to shut down is only a matter of 5 min. When shutting down for the night it is preferable to spray the coke; *e.g.*, in the case of the 3 cwt. per hr. furnace, with 19 to 24 gal. of water about 15 min. before closing down. This procedure reduces the coke consumption during the night.

Efficiency of Furnace

Some 90 to 95 per cent. of the heat of the coke is transferred to the hot waste gases, the only heat losses being from the walls of the furnace. Radiation from the fire at the step grate is prevented by "breezing-up" the steps.

The following are the results of one test made on a grass-drying plant:

Duration of test .. .. 15·33 hr.
Water ratio of the grass .. .. .. 4·45 to 1

1	2
Dried grass produced, cwt.:	
Total	46·1
Per hr.	3·0
Water evaporated, cwt.:	
Total	205·1
Per hr.	13·35
Coke used, cwt.:	
Total	23·6
Per hr.	1·86
Water evaporated, lb. per lb. of coke	7·18
Drying temperature, ° F.	285
Resistance of fuel bed, in. w.g.	0·17 to 0·24
C.V. of coke, B.Th.U. per lb.	12,270

The average evaporation obtained on a number of driers during 1936 was found by E. J. Roberts, of the Agricultural Research Council,[19] to be 5 lb. per lb. of coke. The results obtained on these plants represent a large increase in efficiency, most of which may be attributed to the semi-producer furnace.

APPENDIX

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Cast Iron Research and the Gas Industry

by

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Communication No. 183

GAS MANUFACTURE

Service Requirements

Cast iron alloys interest the gas engineer from four service aspects, involving mechanical strength, heat-resistance, corrosion-resistance, and wear- or erosion-resistance. Service requirements dictate the choice of material, which in some applications is comparatively simple, while in others mutually antagonistic requirements necessitate a compromise. Progress in each of these directions is indicated, and possible applications will be sufficiently evident to render elaboration at this stage unnecessary.

Mechanical Strength

Mechanical strength is of primary interest to the plant designer and the use of tensile or transverse strength figures affords the readiest means available of comparing irons among themselves. Furthermore, provided the structures remain similar, an increase in strength does generally imply an increase, not necessarily a proportionate increase, in hardness and wear-resistance, and to some extent, also in heat- and corrosion-resistance, although for wear-, heat- and corrosion-resistance of a high order, structures other than those most convenient for ordinary mechanical requirements are preferable.

Testing

Mechanical tests are readily taken and a given test represents an inherent property of the material, which is virtually independent of the conditions of testing, but great difficulty is experienced in finding criteria for heat-, wear- and corrosion-resistance, for these do not represent inherent properties, but properties which vary with and depend upon external conditions. They are largely functions of conditions of application and these vary so widely that simplified and accelerated laboratory tests, useful as they may be in indicating what may profitably be tried under service conditions, are less reliable guides than actual service trials.

Furthermore, service conditions often involve two or more properties, such as heat and wear, or heat and corrosion, each of which affects the other in a way only indicated by a service type of test, advantageous as it may be to conduct this under the controlled conditions associated with a laboratory test. Test results quoted for these properties in this Paper, or noted elsewhere, should be taken as illustrative only, the actual material recommended for a given application being made only after careful consideration of all relevant details. Such details are often very difficult to obtain, the operating conditions frequently differing from those that are believed to operate, and examination of an actual failure is always a useful preliminary step. Improved service life must always be considered in relation to any additional cost incurred in achieving it.

What Cast Iron Is

The ferrous alloys usually considered as cast irons are essentially alloys of iron and carbon, containing more carbon than the steels. The dividing line between the two is not precise, and while in pure iron-carbon alloys a carbon content of 1·7 per cent. is regarded as the upper limit of the steels, it may in commercial alloys fall to 0·8 per cent. and yet yield a cast iron structure, verifiable by the microscope, on account of the presence of other elements of composition.

Ferrite

Pure iron, illustrated commercially by electrolytic or wrought iron, consists of grains or crystals of the soft, ductile material metallurgically termed ferrite (Figure 1A). Carbon causes the formation with some of the iron of iron carbide, termed cementite, but when present in small quantities, as in mild steel, the cementite forms with the ferrite, according to the amount of carbon present, grains of an aggregate consisting of fine laminæ of both constituents, termed pearlite, shown in the darker areas of Figure 1B.

Pearlite

This duplex structure behaves up to a comparatively elevated temperature as a simple material, and is harder, stronger and less ductile than ferrite. The actual carbon content of pearlite is about 0·9 per cent., so that steels below this figure are aggregates of ferrite and pearlite grains (Figure 1B) and at this figure are wholly pearlitic (Figure 1C). The pearlite of cast iron is structurally identical with that of steel, although the ferrite portion may contain hardening elements, such as silicon, in solution.

Cementite

If the content of carbon increases still further, cementite exists in the free or massive condition (the white needles and network of Figure 1D) and at 6·6 per cent. carbon the whole structure would consist of hard, brittle cementite. Cast irons seldom contain more than 3·6 per cent. carbon, but a pure iron-carbon alloy of this carbon content, or a commercial cast iron of low silicon content or chilled in manufacture, has the hard, brittle property associated with the predominating cementite constituent (Figure 2A).

White Iron

These so-called white irons have their uses for certain types of service, in spite of their brittleness, and they also form the first stage in the manufacture of malleable cast irons, the white castings being annealed to yield a soft and ductile material consisting, according to initial composition and annealing cycle adopted, of a matrix of ferrite or pearlite, or both, with graphite in the nodular, temper-carbon form. (Figures 2B and 2C show typical whiteheart and typical blackheart respectively.)

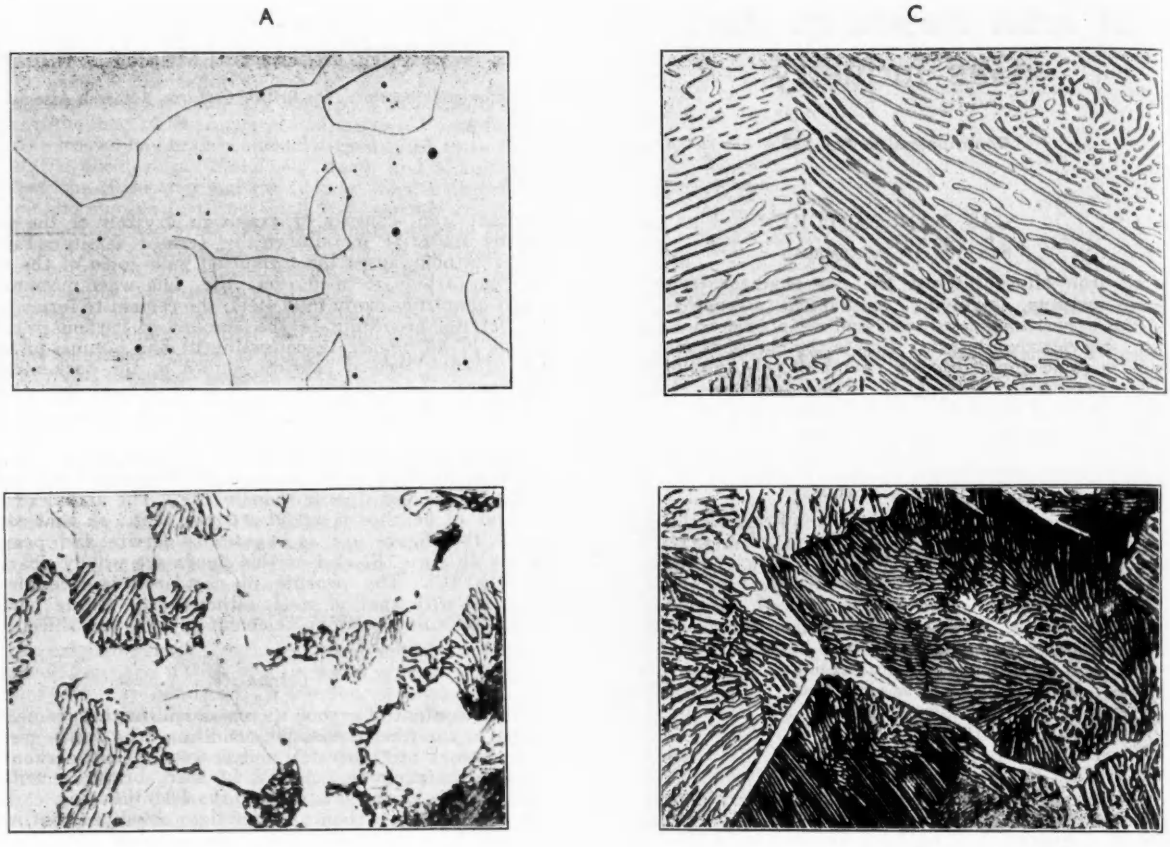
Malleable Cast Iron

Malleable cast irons are covered by British Standard Specifications Nos. 309-1927 and 310-1927, the former relating to whiteheart, which normally tends to be pearlitic, and the latter to blackheart, which normally tends to be ferritic. Minimum values for these irons are as follows:

Table 1.—*Minimum Values for Malleable Cast Irons*

——	Ultimate Tensile Strength, Tons per Sq.In.	Elongation on 2 In., Per Cent.	Bend Test.
1	2	3	4
Whiteheart (B.S.S. 309)..	20	5	45°
Blackheart (B.S.S. 310) ..	20	7½	90°

For maximum values, the pearlitic matrix of whiteheart usually gives higher strengths and the ferritic matrix of blackheart higher ductilities, up to 18 per cent. Modern methods of manufacture are tending to minimize the traditional distinction between the two types of material, and strength and elongation depend upon requirements,



A. *Pure Iron (Ferrite).* × 150.
B. *Mild Steel 0·3 per cent. C. Ferrite and Pearlite.* × 1,200.
C. *Steel 0·9 per cent. C. Pearlite.* × 1,200.
D. *Steel 1·5 per cent. C. Cementite and Pearlite.* × 1,200.

FIGURE 1.

although higher strengths are obtained at the expense of ductility and vice-versa.

Grey Iron

In the manufacture of grey iron, the task of the founder is so to adjust the composition and thickness of the casting, which jointly determine the structure formed, the latter through its influence on the rate of cooling, as to produce a machinable material. This involves the elimination of free carbide. The conversion to iron and graphite of carbide in excess of that required to form pearlite is accomplished by the use of silicon. The use of excess silicon, in order to guard against risk of unmachinability, yields a structure of ordinary cast iron consisting of ferrite and pearlite, the carbide of some of the pearlite also having been converted to iron and graphite. Figure 2D shows such an iron, also revealing graphite and phosphide, which may have tensile strengths of 9 to 12 tons per sq.in.

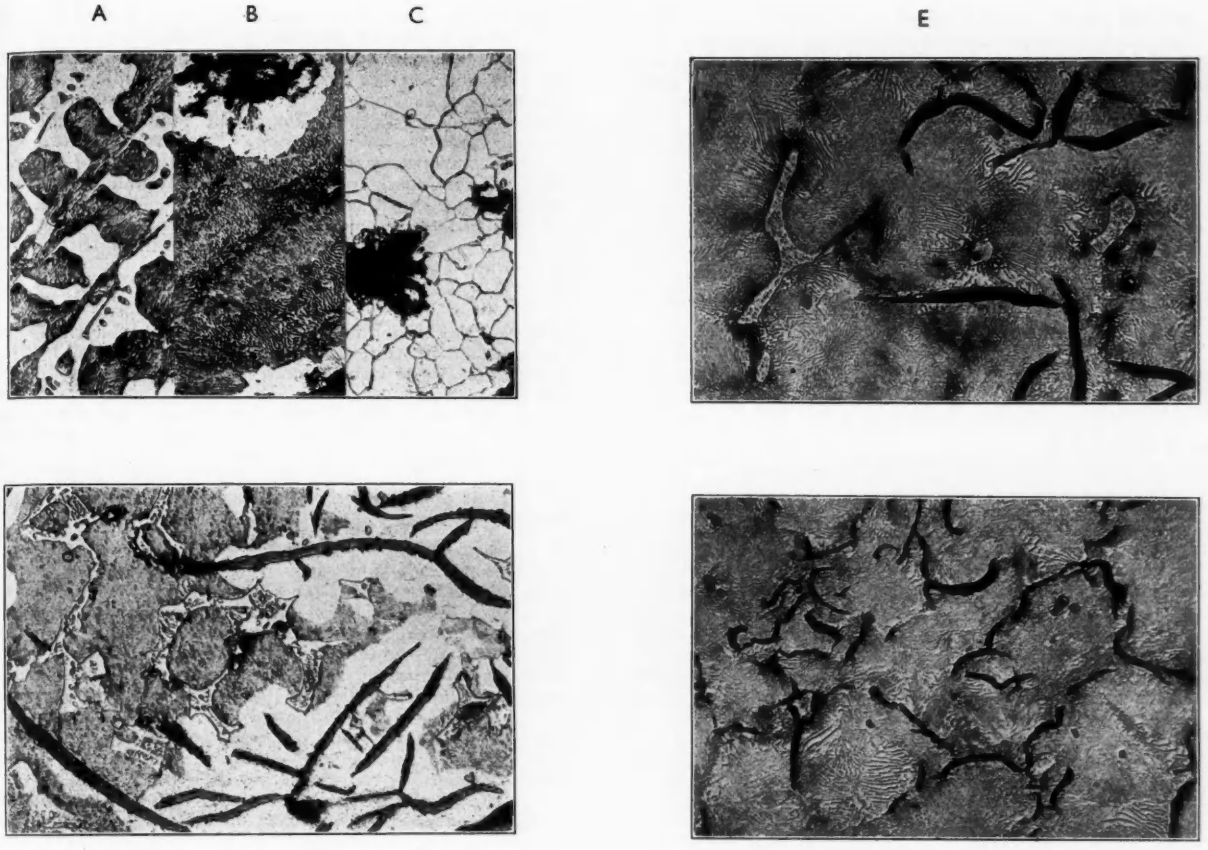
Pearlite is finer in some irons than in others and the duplex structure is only revealed at a higher degree of resolution. Sulphur is usually combined with manganese present as comparatively harmless inclusions of manganese sulphide, and an excess of manganese over that required for sulphur removal is beneficial. The amount of phosphorus present will be governed by engineering, founding and economic considerations, and British blast-furnaces offer users a wide range of pig irons from the hæmatites, almost phosphorus-free, to the phosphoric pig irons containing 1·5 per cent. phosphorus.

Fully Pearlitic Irons

A closer degree of metallurgical control enables fully pearlitic irons to be obtained stronger than the mixed structures shown in Figure 2D, and Figure 2E shows such an iron, consisting wholly of pearlite, broken by small patches of phosphide and graphite flakes. Such irons have tensile strengths of 12 to 18 tons per sq.in. and up to 20 tons per sq.in. with the alloy additions referred to below. The strength of cast iron is governed in part by the properties of the matrix and in part by the size and distribution of the flakes, and by a new foundry technique in which an iron which would otherwise be white is treated in the molten state by a graphitizing agent, higher strengths are obtained, largely through a finer graphite structure. These so-called inoculated irons are also pearlitic and Figure 2F illustrates such an iron. They have tensile strengths of 22 to 26 tons per sq.in. and in special cases a strength of 30 tons per sq.in. has been approached. Two such irons are well known as Meehanite and Nitensyl.

High Duty Irons

High duty irons, both plain and inoculated, frequently contain alloy additions of such elements as nickel, copper, chromium and molybdenum. Nickel and copper may be used in part to replace silicon, which, although softening by breaking down carbide, has an intrinsic embrittling action on the matrix, while nickel and copper harden and toughen, and break down free carbide without affecting that of pearlite. Chromium and molybdenum are carbide



A. *White Iron. Cementite and Pearlite.* × 200.
B. *Whiteheart Malleable. Pearlite, Ferrite and Temper-Carbon.* × 200.
C. *Blackheart Malleable. Ferrite and Temper-Carbon.* × 200.
D. *Grey Iron. Pearlite, Ferrite, Phosphide, Graphite.* × 200.
E. *Grey Iron. Fully Pearlitic, Graphite, Phosphide.* × 200.
F. *Grey Iron, High Duty. Pearlite, Graphite.* × 200.

FIGURE 2.

stabilizers which not only strengthen pearlitic irons but enable them to resist elevated temperatures by postponing carbide breakdown. Carefully made alloy irons are sound, dense and uniform, and for these reasons also resist thermal and corrosive attack better than plain irons. Compositions are carefully balanced to suit the strength required in a given section.

Heat-Treated Cast Iron

By thermal treatment on lines not dissimilar from those used for steels, the mechanical properties of cast iron may be further increased, by about 15 to 20 per cent. for the high duty irons and about 5 per cent. for ordinary irons. The limit of tensile strength for heat-treated cast iron may be regarded as about 33 tons per sq.in. This is a full heat-treatment and must not be confused with the annealing used for stress removal or with the softening treatment (conversion of pearlite to ferrite) used to facilitate high-speed machining. If low carbon alloy cast iron is cast in the white state and heat-treated, the flake form of graphite is suppressed in favour of the nodular temper-carbon form and tensile strengths up to 50 or 60 tons per sq.in. are obtained. Structurally such irons would contain pearlite with free cementite, approximately as shown in Figure 1D, and after heat-treatment the pearlite assumes the spheroidized form, the metal consisting of finely-divided spheroids of carbide in a matrix of ferrite. The production of such metal is clearly related to that of malleable cast iron referred to previously, but it is lower in carbon and makes considerable use of alloy additions, and intermediate strengths may be obtained by suitable composition and treatment. These irons are finding application for such exacting service as crankshafts, camshafts and brake-drums in the automobile and general engineering industry.

Capacity for Distortion

While ordinary pearlitic cast iron cannot be described as a ductile material, it has greater capacity for distortion under stress than is realized by many engineers. The deflection in transverse serves as a criterion, and that part of this deflection represented by permanent set, usually some 20 per cent. of the total, is an index to capacity for resisting shock or impact. Under alternating stress, fatigue or vibration, cast iron behaves well compared with other metals, as the quality called into play is lack of notch sensitivity rather than ductility.

Grey Iron Castings

Table 2 summarizes the general purpose grey irons now covered by British Standard Specifications, of which No.

321-1938 covers Grades A and C of ordinary engineering iron, such as might be represented by Figure 2D, while Grades 1, 2 and 3, as specified in No. 786-1938, cover high duty irons structurally similar to those shown in Figures 2E and 2F.

TABLE 2.—*Strengths of Grey Iron Castings*

Test Bar Diameter, In.	Representing Section, In.	Ultimate Tensile Strength, Tons per Sq.In.				
		Grade A.	Grade C.	Grade 1.	Grade 2.	Grade 3.
		B.S.S. 321-1938.		B.S.S. 786-1938.		
1	2	3	4	5	6	7
0·6	Up to 0·375	12·5	10	—	—	—
0·875	0·375 to 0·75	12	10	15	18	22
1·2	0·75 to 1·125	11	9	14	17	20
1·6	1·125 to 1·625	10·5	9	13	16	19
2·1	Over 1·625	10	9	12·5	15	18

HEAT-RESISTANCE

Effect of Heating and Cooling

When a cast iron is heated, ordinary uniform thermal expansion (about $1{\cdot}4 \times 10^{-5}$) takes place and at about 760° C. a marked constitutional change occurs. At this temperature the carbide of the pearlite dissolves in the ferrite to form a solid solution of iron carbide in iron, known as austenite. This change, without alteration in temperature, is accompanied by a marked contraction in volume. On increase of temperature, any free cementite or graphite begins to dissolve in amounts dependent on the temperature (the maximum amount is 1·7 per cent. carbon at the melting point) and thermal expansion continues.

On cooling the reverse change takes place, the graphite or cementite (in grey or white iron respectively) being reprecipitated. The constitutional change usually occurs at a slightly lower temperature than on heating and is accompanied by an expansion. The expansion on cooling is further augmented by some breakdown of pearlite into ferrite and graphite, a change accompanied by an increase in volume. Such a cycle results in an overall increase in volume and may be termed the growth of the iron for that heating cycle, and will depend upon the extent of the decomposition of the pearlite; in other words, upon its stability.

Effect of Oxidation

When all the carbide is decomposed, the metal is completely ferritic, but growth can continue under heat because oxidation of the metal begins to take place internally through the penetration of hot gases into the graphite cavities; the change from iron to iron oxide is the cause of a decided volume increase, setting up a stress which sooner or later relieves itself in a minute crack, which offers further channels for gaseous penetration and oxidation. This produces the characteristic crazing or honeycomb cracking on the heated surface. The process is essentially one of oxidation identical with scaling on external surfaces, to which all ferrous materials are liable under appropriate conditions. Growth is greater the higher the temperature reached, the longer the time held at that temperature, the greater the number of fluctuations, and, in general, the higher the carbon and silicon contents of the metal and the coarser the flakes of graphite.

Many applications of cast iron involve submission to elevated temperatures, steady or fluctuating, regular or intermittent. The conditions to be met are generally, although not invariably, oxidizing. Where the conditions involve the sudden rise in temperature, such as is found in the case of the ingot mould subjected to the thermal shock and sudden stress due to the impact of molten steel, a high carbon iron with flake graphite, low in phosphorus, is found most suitable, although such an iron is liable to growth on account of the rather open structure, fairly high silicon and coarse graphite. To harden the iron, however, by lowering the silicon and reducing the graphite size, tends to provoke failure by cracking, and the best arrangement is essentially a compromise in which failure by growth is the natural end, since failure by cracking occurs, as a rule, before failure by growth.

Under oxidizing conditions, the choice of an iron will depend upon whether it needs to be machinable, upon the conditions of heating, the cost or ease of replacement (including cost of keeping the plant standing), and the presence of corrosion or erosion. For severe conditions it is often simplest to replace the cheapest type of iron as often as is required, for it must be clearly understood that heat-resisting irons, other than the high chromium irons referred to later, do not melt at higher temperatures, but resist oxidizing conditions better than ordinary irons. Of these irons five categories are available.

White Irons

Where machinability is not required and brittleness is not a handicap, white irons may be used (Figure 2A). The high carbon white irons contain more cementite, and hence are harder and more brittle, than the lower carbon white irons, and the carbide may be stabilized by chromium and/or molybdenum. Such irons contain no free graphite and hence do not grow, but under severe conditions they are liable to scale. They are often suitable under combined heat and erosion. Further reference is made later to wear-resistance.

Grey Irons

Ordinary machinable grey irons, particularly if sound, dense and close-grained, can be rendered more resistant to heat by a small addition of chromium or molybdenum. The use of nickel with chromium renders change in the silicon content unnecessary, in addition to aiding soundness and uniformity. Such irons should not be used above 700° C. as this is nearing the pearlite change. Phosphorus is usually present as a hard, rigid phosphide network throughout the metal and this may serve to keep the structure rigid, but above 900° C. the phosphide rapidly becomes plastic. Grey irons retain their mechanical properties well at elevated temperatures, usually being only slightly weaker at about 250° C. and keeping their air temperature strength up to 400° C. The thermal conductivity of pearlitic iron depends somewhat on composition and falls slightly as temperature increases. It may be taken as 0·11 to 0·14 unit at 100° C. The use of pearlitic irons is advised where temperatures are moderate and mechanical strength is desirable.

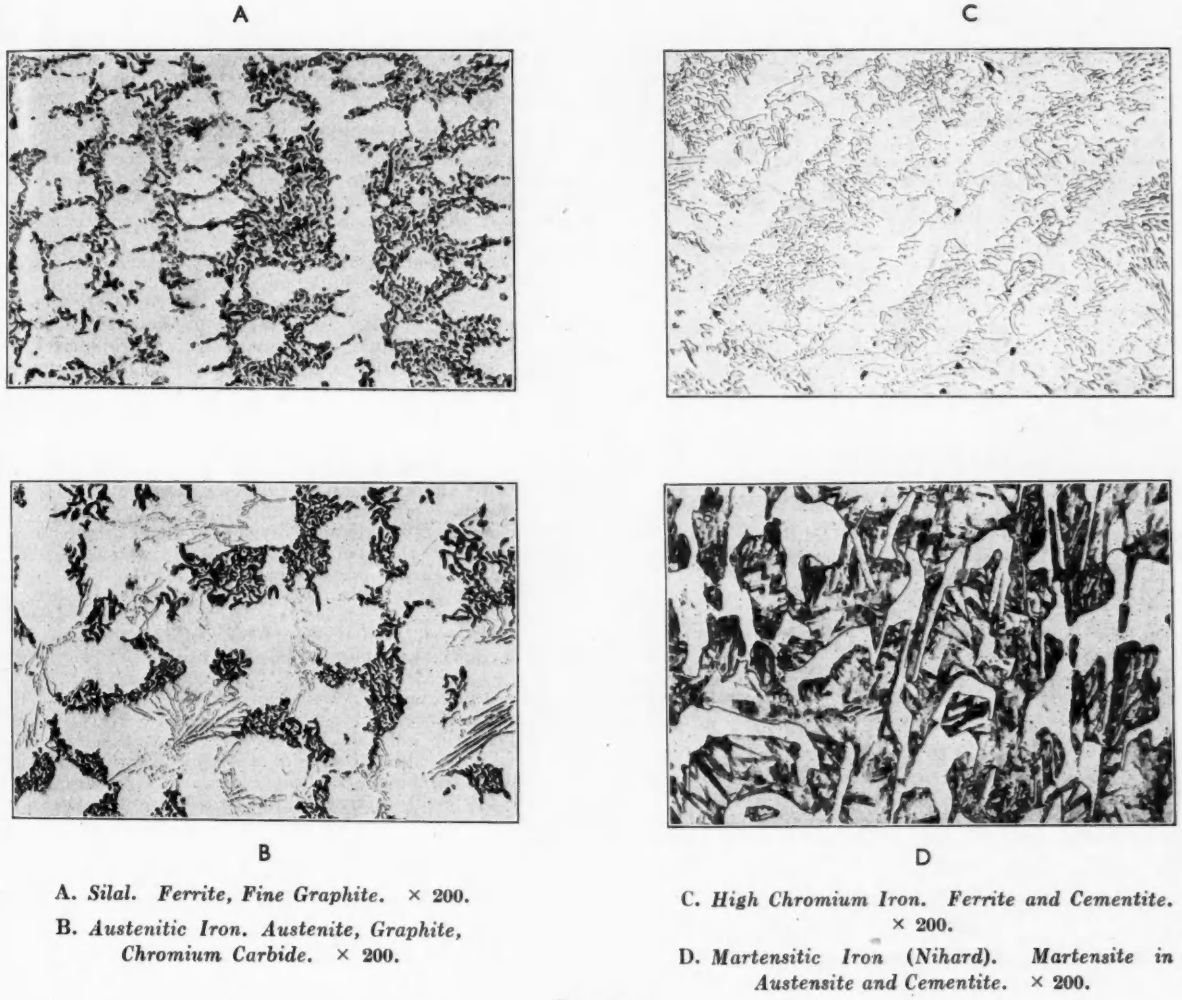
High Silicon Irons

This type of iron is low in carbon and high in silicon and was developed by the British Cast Iron Research Association (British Patent 323,076). It contains 4 to 10 per cent. of silicon and about 2·5 per cent. of carbon, and consists of fine graphite and ferrite. There is no carbide to break down, the silicon makes the metal highly resistant to oxidation, and the small quantity of fine graphite (due to the low carbon) prevents the ingress of oxidizing gases. The silicon also raises the constitutional change to over 900° C., up to which temperature these irons may be regarded as suitable. The most serious disadvantage of the material, which is relatively cheap, is its brittleness, although at operating temperatures it is much better in this respect than at air temperature. The structure is shown in Figure 3A.

Aluminium confers considerable heat-resistance on cast iron, and has been used in Silal, but aluminium cast iron is not easy to make into sound castings. Development of a range of aluminium cast irons is now proceeding in the British Cast Iron Research Association's laboratories under the name Cralfer.

Austenitic Irons

By means of alloy additions it is practicable so to lower the pearlite change point that it is reduced below atmospheric temperature, and such irons are austenitic in the cold state. Structurally they consist of comparatively fine graphite in austenite, with or without chromium carbide, depending on whether or not any chromium is present (Figure 3B). These irons are markedly different in properties from the pearlitic irons, for they are very soft and ductile, have quite good mechanical properties, and are non-magnetic, in addition to having the wear-, heat- and



A. *Silal. Ferrite, Fine Graphite.* × 200.

B. *Austenitic Iron. Austenite, Graphite, Chromium Carbide.* × 200.

C. *High Chromium Iron. Ferrite and Cementite.* × 200.

D. *Martensitic Iron (Nihard). Martensite in Austensite and Cementite.* × 200.

FIGURE 3.

corrosion-resisting properties referred to later. They take a high finish and have a thermal expansion rather higher ($1{\cdot}8 \times 10^{-5}$, compared with $1{\cdot}4 \times 10^{-5}$ for pearlitic iron) and a thermal conductivity rather lower than pearlitic iron. They retain their strength and rigidity at elevated temperatures to a much greater extent than ordinary cast irons and steels.

The first austenitic iron made, Nomag, is used essentially for its non-magnetic properties. Two have been developed for corrosion- and heat-resisting purposes, Niresist and Nicrosilal, the latter a development of Silal, by the British Cast Iron Research Association (British Patent 378,508). Such irons have no critical change, because there is no pearlite point above air temperature, and thus they cannot be hardened by heat-treatment. Approximate compositions are given in Table 3.

TABLE 3.—*Approximate Compositions of Heat-Resisting Irons*

—	T.C.	Si.	Ni.	Cu.	Cr.	Mn.
1	2	3	4	5	6	7
Silal ..	2·0 to 2·5	4·5 to 6·0	*Nil*	*Nil*	*Nil*	0·5 to 0·8
Niresist ..	2·7 to 3·1	1 to 2	13 to 15	5 to 7	1·25 to 4·0	1 to 1·5
Nicrosilal	1·5 to 2·0	4·5 to 6·0	18 to 20	*Nil*	1·5 to 4·0	0·5 to 1·0

Nicrosilal containing less than 17 per cent. nickel and more than 5 per cent. silicon is liable to change in part to martensite in the temperature range from 500° C. to 700° C. The result of ten heats of three hours' duration at 950° C., from tests made by Vickers-Armstrongs Limited, Barrow-in-Furness, on two high quality engineering irons, structurally similar to those shown in Figure 2E, and Nicrosilal of low and high chromium content, showed that the engineering irons grew 70 and 40 per cent. respectively in volume (21 and 11 per cent. in weight), while the former Nicrosilal decreased 2·5 per cent. in volume and the latter increased 0·4 per cent. Both decreased in weight, 5 and 1·3 per cent. respectively. Slight non-adherent scale caused the drop in weight.

By suitable compositions and/or a rapid rate of cooling, castings can be made of martensitic structure, being hard and unmachinable, but having some very suitable applications (Figure 3D). For present purposes martensite can be regarded as a form of austenite having, however, very different properties.

The cost of austenitic irons is a handicap to the wide use which their special properties justify, but they should be considered where the highest degree of combined machinability, strength, and resistance to heat, wear and corrosion is desired.

High Chromium Irons

Iron-chromium alloys containing up to 13 per cent. chromium are highly resistant both to heat and corrosion and formed the early stainless steels. Carbon, however, is essential to ensure castability in a cast metal, and forms chromium carbide at the expense of that chromium required to dissolve in the matrix and confer resistance to corrosion. This can be overcome by using further chromium to combine with the carbon present, and cast-

able alloys can be made with 1 to 3 per cent. carbon and up to 35 per cent. chromium. The amount of carbon depends upon conditions of manufacture, but for a machinable material, 2 per cent. carbon should not be exceeded, although both raw materials and manufacturing costs increase as the carbon falls.

These irons, while not generally so highly resistant to corrosion as the high silicon irons (15 per cent. Si) used in the chemical industry, offer better resistance to heat than any other iron and will resist temperatures up to 1,100° C. Of special interest to the Gas Industry is the fact that these irons offer the best possible resistance to sulphur and sulphurous gases, hydrogen sulphide, sulphur dioxide and sulphur trioxide. Structurally they consist of ferrite and carbide (Figure 3C).

The tensile strength of these irons is about double that of an ordinary engineering iron, and this value increases slightly up to 500° C. Their ductility is about that of ordinary cast iron, but they are harder to machine. Molybdenum enhances the resistance of the iron-chromium alloys against attack by some reagents.

TABLE 4.—*Properties of Heat-Resisting Materials*

——	Silal Type.	Austenitic Type.	High Chrome Type.
1	2	3	4
Tensile strength, tons per sq.in.	10 to 12	15 to 25	25 to 30
Tensile strength, tons per sq.in. at 800° C.	2·5	3·5	7
Elongation, per cent.	*Nil*	2 to 3	*Nil*
Thermal expansion	$1·4 \times 10^{-5}$	$1·8 \times 10^{-5}$	$1·4 \times 10^{-5}$
Thermal conductivity:			
Units at 100° C.	0·088	0·070	—
Units at 430° C.	0·082	0·063	—
Brinell hardness	180 to 300	150 to 300	250 to 350
Magnetic properties	As grey iron	Non-magnetic	As grey iron

Properties of Heat-Resisting Irons

The properties of the specifically heat-resisting materials may be summarized as in Table 4.

The following figures have been published by N. P. Inglis,[1] but the 35 per cent. chromium irons are not included in the last entry:

TABLE 5.—*Temperature Resistance of Heat-Resisting Irons*

——	Temperature at which Serious Deterioration occurs (Growth and Scaling). °C.	Temperature at which Appreciable Scaling occurs. °C.	Recommended Maximum for Practical Use. °C.
1	2	3	4
Ordinary cast iron	500	500	450
Pearlitic cast iron	650	500	550
1 per cent. chromium cast iron	750	550	600
Silal (4 to 10 per cent. Si) ..	900	800	750
Nicrosilal and similar high Cr and Ni-Cr cast irons ..	No change up to 1,000	900	950

Effects of Thermal Shock

Reference has been made to the effects of thermal shock. The comparative brittleness of the alloys high in silicon, aluminium or chromium may cause difficulty where metal is required to withstand sudden and considerable temperature changes, which, of course, result in mechanical stress due to expansion and contraction, or where a steep thermal gradient exists. Under these conditions a hæmatite iron offers the best service, and the higher the carbon and graphite content the greater will be the thermal shock resistance. To illustrate this point, four bars of Nicrosilal of various compositions, two of Silal and two of hæmatite, were repeatedly heated to 700° C. and quenched in water. After four of these severe quenchings, the Silal bars showed small, but visible, cracks. After ten quenchings the Nicrosilal bars developed cracks, while the hæmatite bars withstood a dozen quenchings, although very badly scaled. The bars were holed and notched to see whether these would originate premature local cracks, but this was not the case. Heat-resisting irons, even when comparatively brittle in the cold, are much tougher at operating temperatures, when ordinary machinable irons are apt to become plastic. Thus a bar maintained at 850° C. and loaded cantilever fashion at one end gave a deflection of 1·9 in. in four days in the case of a pearlitic iron, 0·32 in. in the case of Silal and 0·08 in. in the case of Nicrosilal.

Corrosion-Resistance

Cast iron normally offers excellent resistance to corrosion compared with other ferrous materials not specifically manufactured to resist it. To dilute and strong acids and alkalis it offers resistance as good as, or better than, that of steel.

Soundness and uniformity of the casting are of great importance in resisting both corrosive and thermal attack. The variety of the influences exerted by each element prevents the influence of elements of composition being simply stated. Thus, in so far as silicon graphitizes the metal and its increase is likely to produce coarser flakes, it is detrimental, but in so far as it goes into solid solution it aids in resisting corrosion, just as it aids in resisting heat, and indeed the most highly corrosion-resisting ferrous material is the 14 to 15 per cent. silicon iron so widely used in the chemical industry. Phosphorus does not materially affect resistance to acid corrosion, but lowers resistance to corrosion by alkalis.

Occasionally cast iron corrodes under circumstances which prevent the removal of oxidation products. The ferrite and pearlite are oxidized and the soft and friable oxide is held together by the interlacing strands of graphite, the shape being retained when other ferrous materials would have completely disintegrated. This phenomenon, erroneously labelled " graphititis " (graphitic decay or softening), is, however, not common.

Generally speaking, little can be done to improve the corrosion-resistance of machinable pearlitic grey irons by modifying the normal elements of composition, but low alloy additions do help considerably, in part by increasing soundness and homogeneity. Chromium present as carbide is detrimental, but nickel is advantageous and can be combined with chromium in proportions which permit the latter to go completely into solution.

TABLE 6.—*Comparison of Corrosion-Resistance of Austenitic and Ordinary Irons*

——	Relative Loss in Weight per Unit Area in Unit Time.		
	$N.H_2SO_4$	N.HCl	$N.HNO_3$
1	2	3	4
Ordinary grey iron	328	301	218
Hæmatite	301	253	284
Niresist	2·8	1·5	214
Nicrosilal	1·5	1·5	163

The austenitic irons, Niresist and Nicrosilal, already referred to, are, next to the high silicon and high chromium irons, the best available corrosion-resisting irons and are very soft, machinable, and take on a high finish. They have a corrosion-resistance comparable with that of phosphor bronze, being 2 to 200 times as resistant as ordinary cast iron, according to the medium. The figures in Table 6 will give some idea of relative resistances.

The resistance of high chromium irons is referred to later.

Corrosion at Elevated Temperatures

Corrosion at elevated temperatures involves both thermal and corrosive attack. Many surface treatments have been proposed, some being successful, in promoting resistance to heat and corrosion, but extended consideration would unduly prolong this Paper.

In practical operations, corrosion may take place through solid, liquid or gaseous media. oxidizing or reducing, and irons containing chromium, silicon or aluminium are required to resist oxidizing gases at elevated temperatures containing sulphur compounds. No ferrous material can indefinitely withstand reducing conditions at high temperatures in the presence of sulphur. At elevated temperatures the effect of combustion gases, hydrogen, gases containing hydrogen sulphide, and carbon dioxide, surpasses

that of air or steam in the ascending order given, the effect of carbon dioxide being four or five times as severe as that of air.

Corrosion by Gaseous Hydrogen Sulphide

In a laboratory study of the resistance of ferrous materials to corrosion by gaseous hydrogen sulphide,[2] the nickel cast iron Niresist had a resistance superior to all other materials tested (including plain and alloy steels, wrought and cast irons) except steels containing 12 to 27 per cent. chromium and steels containing 5 per cent. chromium, although the high chromium cast irons which would correspond with the high chromium steels were not tried. These would be expected to give high resistance. A somewhat similar ratio of resistance between ordinary cast iron and Niresist has been recorded in smoke scrubber and other tests where coal gas, sulphur and acid vapour combinations occur, in exposure to saturated hydrogen sulphide at 80° C., and in resistance to various forms of chemical attack.

Action of Sulphur Dioxide

B. Waeser[3] says that sulphur dioxide will not attack retorts of cast iron or steel where it cannot dissolve in the condensed form, and that oxidizing gases containing sulphur dioxide attack considerably iron and iron alloys at 400° C. to 600° C. The layer of oxide and sulphate formed then protects the metal from further attack, so long as condensed acid water does not injure it. He quotes Rebald's (1931) figures showing the drop in the sulphur absorption by iron-chromium alloys as the chromium increases. He also quotes Dittrich (1933), who mixed hydrogen sulphide and hydrogen at various temperatures and pressures and found that high alloy chromium cast iron resisted corrosion up to about 375° C., a higher temperature than any other material tried, including alloy steels. For mixtures of hydrogen sulphide along with both carbon monoxide and carbon dioxide, which may also contain hydrogen, high alloy chromium castings are relatively the most resistant. He concludes that reducing conditions should be avoided, but, if necessary, low carbon monoxide and carbon dioxide percentages should be aimed at and a high alloy chromium cast iron used for constructing the apparatus. These conclusions suggest the study of high chromium irons for use on Gas Works plant.

WEAR-RESISTANCE

Cast iron has always been recognized as having high resistance to wear, as its universal use for cylinders, piston rings, and liners testifies. There is no general relation between hardness, mechanical properties and wear or erosion, but in irons which are structurally similar an improvement in strength, hardness, uniformity or closeness will result in better resistance to wear. The harder the metal, the more important surface finish becomes. Alloy additions are helpful. Much work has been done on wear-resistance, but here again working conditions differ so much that prediction must be confirmed by a service test. Within ordinary limits, pressure and temperature do not appear greatly to affect wear. Phosphorus generally improves resistance to wear. Other things being equal, a pearlitic iron wears better than a ferritic or mixed ferrite-pearlite iron. For exceptional wear-resistance, especially where both wearing parts are metallic, nitriding or chromium plating may be used. By means of nitrogen hardening, Brinell figures up to 1,000 may be obtained.

White irons (Figure 2A) have advantages for wear-resistance in such services as coal preparation and for the crushing and preparation of coke, in which wear on ordinary ferrous materials is severe. An alloy iron of this kind, Nihard, is the hardest and toughest cast iron available and has alloy additions comparable with those used in the wear- and abrasion-resisting steels. The principal additions are 4 to 5 per cent. nickel and 1·5 to 2 per cent. chromium, giving a martensitic iron with a Brinell hardness in excess of 600 in the sand cast state, and able to scratch or cut glass. The carbon and silicon contents are respectively about 3·5 and 0·75 per cent. and the properties are as follows:

TABLE 7.—*Properties of Ordinary Cast Iron and of White Iron (Nihard)*

—	Ordinary Cast Iron.	Nihard.
1	2	3
Brinell hardness—chilled	500	650 to 700
Tensile strength, tons per sq.in.—chilled	15 to 18	25 to 27
Tensile strength, tons per sq.in.—grey	8 to 11	13 to 16

The structure is shown in Figure 3D, and consists largely of martensite. Care should be used in applying white or martensitic irons where shock or impact has to be withstood.

GAS DISTRIBUTION

CENTRIFUGAL CASTINGS

The use of cast iron pipe for water mains preceded the rise of the Gas Industry and such pipes, laid between two and three centuries ago, are still in service. Originally made horizontally, first inclined and then vertical casting superseded the original method. Over a century old in conception, the first practicable process for the centrifugal casting of pipe was evolved in 1914, and its major application, first in this country, began in 1921. The original Delavaud process provided for the production of pipes by the rotation of water-cooled metal moulds, following which an annealing process was essential. More recently, by the use of an insulating powder, coating the metal mould before pouring, it became possible to cast the pipe without annealing, but by a combination of the controlled use of the mould coating and a subsequent normalizing treatment, it has been found possible to produce spun pipes with a much higher impact or shock strength than previously. In parallel with the later development of the metal mould process there was devised the process for making centrifugal pipes in sand moulds. Today large and modern works, equipped in a way which has involved great capital expenditure, are engaged on the production of centrifugal pipes and are able energetically to pursue any development of value.

Of the advantages of the centrifugally-cast pipe there is no doubt. Made on a continuous basis, it is controlled at every stage of manufacture with respect to raw materials and methods, and a very high degree of uniformity is achieved. The closeness and density of the metal permit a diminished thickness, with an even higher factor of safety, giving lower cost, increased fluid flow and easier transport. Pipes from 3 in. (sometimes from 2 in.) to 24 in. in diameter are supplied to the Gas Industry, which takes nearly half the output of one large works. Another firm has supplied 25,000 miles of spun pipe, about one-third being to the Gas Industry. It is probable that nearly half the output of cast iron pipe in this country is used for gas distribution. The centrifugal process has made practicable the use of cast iron for high pressure mains (5 to 10 lb. per sq.in.).

By adopting the 18 ft. length, joints are fewer and assembling is simplified. Considerable ingenuity has been expended on the provision of joints which combine the necessary tightness with a degree of flexibility for meeting modern traffic and laying conditions, a total variation of 8° or 10° being possible between adjacent pipes. These joints are also made chiefly of cast iron and it is interesting to note that high duty iron is used for the bolts, so that all parts of the complete pipe offer the same resistance to corrosion.

CORROSION-RESISTANCE

On account of less corrosion troubles, many gas engineers prefer cast iron to other ferrous materials, because even with coated pipes perforation leads to decay in aggressive soils. In such soils a bitumen coating of ¼ in. appears to meet the case for cast iron pipes.

The relative advantage enjoyed by cast iron in corrosion-resistance has been demonstrated during the past twenty years by the work of a Committee of the Institution of Civil Engineers in studying the deterioration of structures in sea water. This work is being extended, through the

Corrosion Committee of the Iron and Steel Institute, to soil corrosion. For some fifteen years past the U.S. Bureau of Standards has made an elaborate series of studies of soil corrosion,[4] and again cast iron emerges very satisfactorily. The materials tested included steel, cast iron and malleable cast iron, wrought iron, many non-ferrous alloys and coated materials. The work is not yet complete, but it has gone far enough to show that cast iron corrodes to an extent only slightly in excess of far more expensive materials. In view of its relative cheapness, cast iron pipe has a far better ratio of cost to life than any other ferrous material. In 1934 a paper to the American Water Works Association[5] on the same data concluded that none of the rolled ferrous pipe materials showed outstanding superiority in all soils at the end of ten years, and that while the cast iron specimens had rather more loss in weight and depth of pitting than rolled materials, this was not in proportion to the greater thickness of the cast iron pipe. Finally, the corrosion of high-tensile cast iron, malleable cast iron and cast steel was not notably different from that of pit cast pipe. The conclusions also referred to the protective coating investigation of the American Gas Association and the American Petroleum Institute. The conclusions are drawn that paint films and unreinforced soft coatings are of doubtful value in any soil; that the effectiveness of coating markedly increases up to 0·1 in. in thickness; asphalt emulsions are probably too soft to resist penetration by soil pressure; soil stresses are one of the most destructive agencies affecting coatings on the outside of buried pipes, and thick hard enamels or reinforced or shielded coatings appear to be required.

GAS UTILIZATION

Light Castings

It is not necessary to go into the importance of cast iron in consumers' appliances beyond recognizing that every gas engineer is interested in the development of simple, attractive, convenient, safe and economical means whereby gas may be made to serve the purposes of domestic life. Anyone visiting a modern trade exhibition is astonished at the variety of such appliances—stoves, cookers, boilers, fires, heaters, radiators, water heaters, washing machines, refrigerators, irons. Their manufacture is the concern of the light castings sections of the foundry industry, now widely spread throughout the country, but having its historic origin in Falkirk, where the British Cast Iron Research Association has a branch laboratory. During the last few years considerable rationalization has taken place in the industry, and a number of firms are now linked in a few small groups. The specialization thereby permitted has facilitated broader policies with respect to publicity and advertising, research and development, which will be increasingly reflected in the quality of the product.

Broadly similar to that of the other branches of the industry, the technique of light castings production involves such delicacy of touch that the operative develops special manipulative skill peculiar to his branch of work. The use of phosphoric irons enables the molten metal to take sharp impressions of the mould. The manufacture of light castings calls for the provision of very hot metal of closely controlled composition to yield grey and machinable iron in the very thin sections involved. It calls upon all the resources of the metallurgist and foundry manager in sand control and in melting and moulding practice, especially in overcoming the natural shrinkage of the metal during cooling. In two directions notable advances have been made; firstly, in the planning of methods of continuous production and the development of the necessary plant for moulding, sand conveying, sand treatment, and so on; secondly, in the application of improved finishes.

Enamelling

Shot-blasting the finished casting has become a universal preliminary to the application of some form of vitreous enamel, now available in a wide variety of colours of great charm. The ceramic base is applied either in fluid or powder form to the carefully cleaned casting, which is then fired to give a hard, vitreous coat which can be readily cleaned. A large number of light castings foundries are equipped to finish their castings in this way and some of the most difficult technical problems the industry provides arise in this work. The development has been rapid, but research is being carried out to permit close control both of the enamel and of the process. Furthermore, enamels are now being used which are much more resistant to the fruit and other acids with which they may become contaminated, and these acid-resisting enamels, more difficult than ordinary enamels to apply, are in more general use in this country than elsewhere.

Apparatus for Industrial and Public Uses

Of apparatus involving the use of gas for industrial and public works purposes, it need only be said that the problems provided are broadly similar to those arising with respect to Gas Works plant itself.

FUTURE INVESTIGATIONS

Sufficient has been said to indicate that a range of cast irons is now available yielding structures in which any one of all those metallurgically possible may predominate and having properties capable of meeting the requirements of special cases.

The Author ventures to suggest that co-operation between the Gas Industry, either through individual Gas Undertakings or collectively, and the founding industry, through the British Cast Iron Research Association, might assist in dealing with the more complete application of modern cast irons in gas manufacture. Indeed, it might be suggested that there is room for a specific investigation into heat-resisting and corrosion-resisting irons under the conditions in which they are required to work in gas manufacture, distribution and utilization.

The British Cast Iron Research Association's developments described in this connexion arose largely as side issues from a more general and fundamental investigation, and the opportunity to complete the work has hitherto been lacking. The Council of the Association would welcome any arrangement which would place its special knowledge and experience at the disposal of the Gas Industry, and in this connexion might stress the world-wide contacts from which information on developments elsewhere is drawn, the close contact with industry and with other Associations and laboratories working in allied fields, and the central laboratories and expert staff available, dealing not only with investigation, but with application under working conditions.

The requirements of the Gas Industry—including comprehensively in this the manufacture of gas in by-product coke plants, town gas and water gas—are peculiar to it, involving special conditions with respect to heat-corrosion and erosion, sometimes under oxidizing conditions and sometimes under reducing conditions. Ovens, retorts, coke-handling plant, quenching plant, and plant for ammonia and sulphur removal, need to have the special conditions examined for each type.

So far as mechanical properties are concerned, the British Cast Iron Research Association is carrying out an investigation, sponsored by the Institution of Mechanical Engineers, on the whole range of cast irons, in respect of their mechanical properties for use in design. A specific investigation into heat- and corrosion-resisting materials from the point of view of the Gas Industry would enable the problems raised in the design, operation and maintenance of such plants as scrubbers, condensers, exhausters, boosters, governors, purifiers and valves to be dealt with scientifically with a view to lengthening life. The results obtained could be applied to the fields of gas distribution, public lighting and to plant and appliances involved in the industrial and domestic uses of gas.

APPENDIX

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From Holder to Burner

Communication No. 184

by

W. J. SANDEMAN, M.Inst.Gas E.

(General Manager, Croydon Gas Company)

DISTRIBUTION

Supply Area

The whole of the Croydon Gas Company's gas is manufactured in its Works at Waddon, which are situated approximately 2 miles from the northern boundary of the district and about 14 miles from the southern boundary. The Company's supply area is approximately 73 square miles, and is served by 592 miles of main. A map of the district, showing the Works distribution stations and showrooms, is given in Figure 1.

Plant

A few details of the boosting plants at the Works and of the holder stations are given in Appendix 4.

The type of governor generally used on the district is the Peebles underground type, the pressure being varied by loading an air-bell fixed in a cast iron pillar-box mounted on the pavement adjacent to the governor.

Pressures

Schedules of summer and winter pressures to be maintained on Works and district governors are prepared each year. The summer period extends from 15th April to 14th October and the winter period from 15th October to 14th April. Pressure recorders are fixed at various points throughout the district and daily charts are taken. Apart from these daily charts, two sets of charts of a typical weekday and Sunday are taken every summer and winter at a number of points throughout the district. A graph is prepared from each set of pressures, from which any weaknesses in the distribution system can be detected.

Mains and Service Pipes

Sand- and metal-spun pipes in 16 ft. and 12 ft. lengths are used for all mains up to 14 in. in diameter. Above this size, vertically cast pipes, in accordance with British Standard Specification No. 78-1917, Class A, are used. All pipes and specials are inspected by an independent firm before leaving the makers' works. Steel tubes with welded joints are used for high pressures and where it is necessary to lay low-pressure mains with very little cover. They are also used for bridge crossings and under railway permanent ways.

The type of joint used for all sizes of cast iron mains consists of leaded yarn, a rubber ring and lead wool. All joints for 12 in. pipes and larger sizes are caulked with pneumatic hammers.

Wrought iron tubing is used for services, and in clay soil services are laid in pitch in wooden troughs. Trench digging machines of the " bucket " type are used in virgin soil. Compressors of the Diesel type, run on water gas oil, are used for breaking up road surfaces and supplying compressed air to pneumatic hammers for setting up joints on large sized mains. A thrust-boring machine manufactured by the Hydraulic Engineering Company, Limited has proved very useful when laying pipes from 1 to 8 in. in diameter under concrete roadways and railway crossings.

Explosion power-rammers are used in all cases when filling in trenches and made-up roads. These machines are more effective than hand punners and considerably reduce the amount of surplus material to be carted away. In all

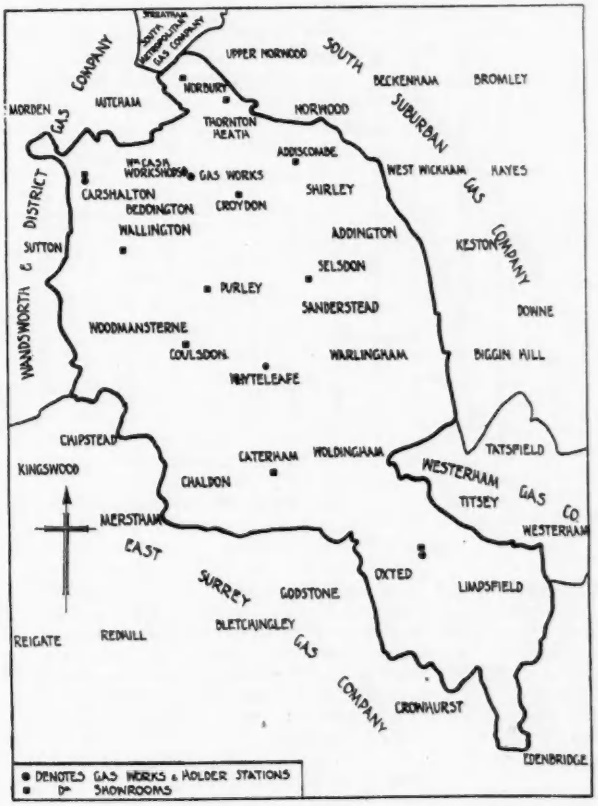


FIGURE 1.—*Area of Supply : Croydon Gas Company.*

districts except one, the permanent reinstatement of trenches is undertaken by the Local Authorities.

Inspection

When re-laying mains, the opportunity is taken not only to examine services but also to inspect all gas appli-

ances in the customers' houses. This has been the practice of the Company for many years, and it has proved invaluable in keeping the district plant in a sound state of repair.

A 30 cwt. " Morris " chassis, fitted with a small rotary pump and a 150-gal. steel tank, is used for pumping syphons. One man inspects the whole of the syphons (about 1,200) in approximately seven weeks.

Records

The costs incurred and the lengths of mains laid, lifted and abandoned are posted to the Mains Mileage Book. A yearly summary is made from this book, giving the lengths of each size of main laid and the total expenditure. Main-laying costs are carefully watched so that the results of one ganger's work can be compared with that of another. Details of all mains are posted on to Mains Record Cards and Ordnance Sheets. Syphon Record and Pumping Cards are also used, and large-scale drawings are made of mains of 12 in. or more in diameter, special connexions, valves, etc.

Public Lighting.

The Company has contracts for 4,135 public lamps, the aggregate annual consumption being 75,126,000 cu.ft. Public lamps are indicated by blue triangles on the Ordnance Sheets, which also give the positions and sizes of the mains. All lamps are fitted with clockwork controllers. The personnel of the Lighting Section consists of a foreman and four assistant foremen (each of whom is provided with a Morris Minor car), one supernumerary foreman and nineteen lamp attendants.

Distribution Load Factor

Before leaving the Distribution Department it is opportune to mention the question of load factor. The load factor on the distribution system over the period of the last 20 years is indicated by the graph in Figure 2. This graph (calculated on the formula due to Stephen Lacey) is based on the relationship of the maximum hourly output to the average hourly output throughout the year. It will be noted from this graph that there is a slight decline in the load factor. This is partly because the Gas Industry is becoming more and more a heating one, and there is a considerable drop in the gas output during the summer months, particularly noticeable in the case of a " dormitory " district such as the Croydon Gas Company supplies. It will be understood, of course, that as the load factor declines, the distribution costs must necessarily increase. Gas business is becoming more costly to conduct, because, although the sales of gas are increasing, the decline in load factor and the fall in the average consumption per consumer increase the distribution costs per therm sold.

Attention may here be directed to the importance of building up the summer-time valleys through water heating and refrigeration, and of cultivating the more even central-heating load during the winter instead of the spasmodic and short period heavy-demand fire load.

SALES AND SERVICE

Planning

The linking-up of the Distribution Department with the Sales and Service Department should now be considered.

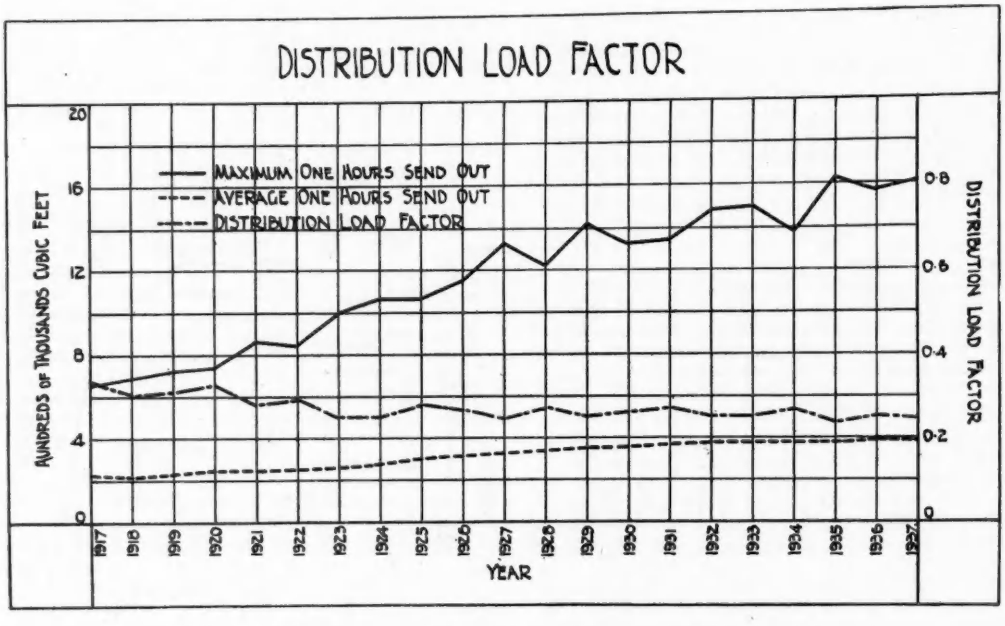


Figure 2.—*Distribution Load Factor, Croydon Gas Company, 1917-1937.*

On paper (as is shown by Appendices 2 and 3) the two departments join forces where the service enters the premises, but in practice matters affecting both departments are discussed between the two departmental officers.

Before any main or service is laid the ultimate potential demand is estimated by the Sales and Service Department, and the Distribution Department furnished with knowledge which will ensure the provision of pipes of adequate sizes. The Sales and Service Department deals with all negotiations in connexion with estate developments and is responsible for seeing that the Distribution Department has full information with regard to the lay-out of estates and other essential data. Co-operation is, in this connexion, effected by means of a Building Sheet, a specimen of which appears in Appendix 5. This form is passed to the Distribution Department, together with a plan of the estate and details of the purposes for which gas will be used. The sizes of mains required in the various roads are then calculated, and where concrete roads occur provision is made for duplicate mains.

Newly Developed Areas

For very many years the goodwill of builders and architects has been cultivated by personal contact, and as a result new houses, with very few exceptions, are adequately piped. The Company, in 90 per cent. or more of the cases, undertakes the carcassing and in many instances supplies and fits cooking stoves, coppers, water heaters, fires and, more recently, refrigerators. There has been a growing tendency on the part of builders in recent years to complete their houses by installing gas appliances, and enormous business has been done with gas fires, complete with surrounds and hearths, or else with the modern plaque settings and flush-fitting fires. Building activities on the district may be gauged from the following figures:—

Total number of consumers:

31st December, 1927	67,061
31st December, 1937	103,315

Miles of main:

31st December, 1927	382
31st December, 1937	592

There is a fixed policy relating to the laying of mains and services and carcassing houses on new estates. Where a builder buys land for development he is quoted an "all-in" price per house, including a substantial contribution towards the cost of the mains, services and carcassing. All service pipes on public highway and 25 ft. on private property are laid free of charge, provided the builder installs a minimum of six fuel points, and extra service, over and above this, is chargeable at a given schedule per ft. according to the size. Carcassing is charged for at 10s. 0d. per point.

Where roads are being constructed, complete with all essential public services, for the sale of building plots, the vendors of the land are required to enter into a Mains Revenue Agreement. Agreements run for seven to ten years, varying with the anticipated rate of building development.

Great attention is paid to developing selling on the district as distinct from selling in the showrooms. There is a special section of the Sales and Service Department, under the charge of the District Development Officer, for dealing with builders and new consumers. Included in this section are the District Representatives and the House Examiners, who, although decentralized and attached to local offices, report through their Inspectors to the District Development Officer. To ensure uniformity of selling methods on all districts, monthly meetings of the District Representatives and House Examiners are held.

District Depots

In district sales and service work decentralization and local representation characterize the Company's policy. There are six depots, each with a showroom, demonstration room, stores, Inspector's department and residential apartments. There are, in addition, three showrooms only, in thickly populated districts, which are served by nearby depots. District stores are replenished weekly from the central stores and motor transport is used as far as possible to reduce the unproductive time occupied by fitters in pushing trucks. The personnel of a typical district depot is given in Appendix 6.

District Inspectors

The District Inspectors meet the Sales and Service Superintendent weekly in conference, and on all matters relating to administration and technical problems they are fully consulted before any changes are made. The Inspectors are responsible for the administration of labour and materials, and for the proper carrying out and supervision of installation and maintenance work, except in the case of large installations, such as industrial and central heating plants, and the like, which require specialized knowledge. This work comes directly under the control of the Technical Section at Head Office. The District Inspectors are encouraged to associate with the various trade organizations in their district, such as Chambers of Commerce, Rotary Clubs and so forth, and to maintain personal contact with special customers.

District Representatives

The District Representatives are concerned with looking after the requirements of newcomers to the district and also changes of tenancies. From various sources early intimation is obtained of incoming residents and of tenancy changes, and a letter offering service and a personal appointment is sent, together with the Company's service folder. The District Representatives follow up these contacts for business and finally see the customers in their new homes after they have been moved in, to ensure that everything has been completed to their satisfaction. Opportunities for future additional business are noted and placed on the "follow-up" list. Very often the District Representative's visit reveals that the customer is not fully familiar, say, with the operation of a cooker oven-thermostat, and then he at once arranges for one of the Home Advisory Staff to call. It is the District Representative's task to see that new customers are properly "fitted up" in good time, so establishing the beginning of a good relationship.

House Examiners

The House Examiners, who also act as district canvassers when competitors make special onslaughts, are generally recruited from the best of the young fitters. They have undergone a five years' course of education, and with proper training make excellent salesmen. They are expected to examine all apparatus throughout the house, rectifying on the spot any minor faults and maladjustments and reporting for attention more involved troubles. For years old and inefficient apparatus has been "weeded-out" in this way and modern replacements introduced, together with additional apparatus.

Showrooms

Passing on to showroom procedure, there is at each showroom a Salesman-in-Charge, with the necessary assistants. For example, at the Wallington depot there is a staff of four; a Salesman-in-Charge, first assistant, second assistant and a girl cashier.

In the arrangement of displays, tickets, etc., the Publicity Officer gives help and advice, but in order not to cramp local initiative and interest, each Salesman-in-Charge is responsible for the satisfactory lay-out and general condition of his showroom. The Publicity Officer also arranges special demonstrations, district exhibitions, film displays, etc.

The Salesman-in-Charge is expected to co-operate fully with the District Inspector, but so far as the district work is concerned the District Inspector is the responsible officer.

The showroom windows are all of the "open" type, allowing great flexibility in window dressing. It has been said that "every gas showroom should symbolize the importance of the Undertaking in the life of the district and should take its rightful place among the other prominent commercial enterprises of the town." The importance of showrooms cannot be overstated. Intensification of competition more and more necessitates better and brighter showrooms, showrooms which are light, airy, well-ventilated and colourful, staffed by fully-trained people who know their work thoroughly and who are enthusiastic.

Districts remote from showrooms are visited from time to time by a show-van. What is virtually a small showroom is taken into these districts, and at the same time a house examination is undertaken, and, of course, new business canvassed.

Home Advisory Service

Realizing the ever-growing importance of Home Advisory Service, the Company has, working from the principal

showrooms, five Lady Demonstrators, each with her own particular district, who conduct the Home Advisory lectures and also visit customers in their homes to demonstrate the proper use of cooking stoves, refrigerators, washing machines, and so forth. Talks are arranged among the various women's welfare and fellowship organizations, and the Lady Demonstrators also act in the capacity of expert judges in cake-making competitions and other domestic arts and crafts. The Home Advisory staff works in close collaboration with such publicity bodies as the Milk Marketing Board, the Potato Marketing Board, the Herring Fisheries Board, and others, and arranges special cookery demonstrations dealing with these particular foods.

This domestic science work is considered by the Author to be one of the most useful forms of practical propaganda. More and more must be done to get into the homes and lives of people with a view to ascertaining how they react to the appliances and service provided by Gas Undertakings. The domestic load is the backbone of the Gas Industry, and so it will remain, and in this connexion the woman's point of view is worthy of the closest study.

Schools, both elementary and secondary, having Domestic Science Centres attached to them, are visited by these Lady Demonstrators, who work in close co-operation with the Science Mistresses. They often arrange for selected parties of children to visit the showrooms and the Works.

Workshops

The William Cash Workshops were acquired in May, 1929, and converted into stove repair shops, stove and general stores, meter testing station, stores office and central garage. There is a Superintendent in charge and also a Chief Stores Officer. It is from this depot that the district showrooms and stores are fed and appliances delivered to customers' houses. The repair shops embrace general repair and fitting shops, sheet metal shop, gas-fired muffle furnace for burning-off stoves, shot blasting plant, japanning and art-enamelling shops. A section of the shops is devoted to the testing of apparatus and fittings, and nothing is allowed to go out on the district unless it satisfies the Company's tests. Another section is set aside as a training centre for apprentices and district staff. All sorts of apparatus are fitted here for demonstration, and fitters, maintenance men and showroom-trainees attend, from time to time, for training and refresher courses given by a qualified instructor.

Pricing and Purchase Agreements

All installation and maintenance work is carried out under a carefully priced schedule of charges. This schedule is checked each quarter by taking a number of work cards from each district and comparing the actual costs with the scheduled rates.

Approved apparatus, whether for hire or sale (either outright or on instalment purchase terms) is priced to include fixing, guarantee and maintenance for a specified period, and varying, with different appliances, from three to seven years.

A wide range of apparatus is available for simple hire. Hire agreements for cooking stoves, heating stoves and coppers are for a minimum period of two years, while water heaters are supplied and fixed under a three years' hire agreement.

A large amount of business is done on the instalment purchase system. Last year over 50,000 instalment purchase agreements were entered into.

Service after Installation

The importance of service after installation cannot be too strongly emphasized. It is folly to flood the district with apparatus unless a maintenance organization exists to take care of it. Considerable harm is done if customers are allowed to become dissatisfied with the performance of equipment, since their reaction causes them to say, not that the apparatus needs attention, but that "gas is no good", an attitude which must prejudice the Gas Industry. Periodic maintenance is an enormous asset in keeping people satisfied.

Meter Reading

Continuous meter reading has been in operation for several years, and its introduction has been more than justified. Before this system was introduced, about thirty men had to be taken from their usual duties for about ten days at the end of each quarter in order to read meters, resulting in disorganization in all departments, whereas now, by employing only six men continually on meter reading, the whole of the work can be accomplished without upheaval. Quicker service to reported faults can also be given, and it is possible to keep a close check on variations in consumption.

Publicity

In regard to publicity, use is made of the local newspapers. Generally large spaces are taken, seldom anything less than 11 in. treble column, and as far as possible an endeavour is made to let the picture tell the story by limiting the text to a few salient points. In Press advertising the Company has the assistance of a London advertising agency and also makes full use of the British Commercial Gas Association's suggestions and block service; the Association also assists in the production of the Company's sales brochures, most of which are printed locally, and it is part of the planned selling to post brochures to residents in selected areas from time to time. Benefit, it is believed, is obtained from reproducing, in brochures and literature, photographs of actual installations, showing a true domestic picture.

Other means of advertising which are arranged by the Publicity Section are showroom displays, designed locally or by the British Commercial Gas Association; fully-equipped show houses, arranged in conjunction with builders and house agents on new estates; seasonable exhibitions and lectures in local stores and in halls on areas comparatively remote from the Company's showrooms; talks to the various Schools, Ratepayers' Associations, Chambers of Commerce, Rotary Clubs, etc., at which use is made of the Company's own cinematograph film "Gas—A Glimpse of its Manufacture and Distribution", supplemented by various British Commercial Gas Association films. Numbers of visits are arranged to the Works. The Company also co-operates with Local Authorities during Health Weeks.

Training of Personnel

Of immeasurable advertisement value is a well-trained and courteous sales and service personnel. The great importance to the Gas Industry of having properly-trained and qualified craftsmen on the district, as well as skilled salesmen, cannot be too heavily stressed.

Boys wishing to become gas fitters are taken from elementary schools at the ages of 14 to 15 years, and undergo six years' special training. At first they receive a three months' preliminary course of instruction at the William Cash Workshops and are then allocated as mates to fitters and sent out on the district. Their training also includes a five years' compulsory course of evening classes at the local Polytechnic. This scheme has worked very well and has produced a number of excellent young men, some of whom have, of their own freewill, gone on with their studies and taken the more advanced courses of The Institution of Gas Engineers.

Fitters are encouraged to qualify for the Gas Fitters' Classification Certificate under the Federation Scheme.

Distribution and sales pupils are taken under a deed of pupilship for five years. They are required, as a preliminary, to have matriculated, and must enter for the Ordinary and Higher Grade Examinations of The Institution of Gas Engineers. They are given practical and commercial training in all sections, with a view to their being

equipped to take charge of a district in the capacity of a " general practitioner ". In these days of specialization it is essential not to overlook one's responsibility to the Industry of training young men, who for smaller Undertakings must have good varied experience.

The selection and training of salesmen and saleswomen is a supremely important matter. Recruits are given a thorough insight into office routine, and receive technical training at the William Cash Workshops and on the district. They are then drafted to showrooms, where they are instructed in salesmanship by the Salesman-in-Charge, and acquire practical experience in selling.

Staff Meetings and Discussions

Regular meetings are held of the practical staff, comprising the Inspectors, their assistants, foremen, District Representatives and House Examiners, when matters of importance are discussed with the Sales and Service Superintendent. The purpose of these meetings is two-fold; firstly, to provide customers with better service, and secondly, to assist the management to a more intimate understanding and appreciation of the practical difficulties which the district staff has to face every day when dealing with customers.

Two main conferences are arranged each year, one in the spring and one in the autumn. Matters relating to sales policy and organization form the basis of discussion, and the opportunity is taken of introducing and explaining newly-approved appliances to those who will be responsible for presenting and selling them to the public. In addition, lectures and educational talks on subjects connected with the Gas Industry are given by experts during the winter season.

GAS SALES POLICY

It is possible to touch only briefly on one or two points relating to Gas Sales Policy. The policy, apart from involving the terms and conditions on which apparatus may be acquired by customers, also embraces, of course, the all-important question of tariffs and discounts.

Two-Part Tariff

Broadly speaking, it appears impossible to devise a general two-part tariff which will assist in measurably increasing the sales of gas to the average domestic consumer taking between 20,000 and 40,000 cu.ft. per annum. It is necessary to set a fairly high minimum qualifying consumption before the two-part tariff will take effect, otherwise existing revenue must inevitably be greatly prejudiced for a problematic increase in consumption. Maintenance of profit cannot be overlooked, and under present conditions it is impossible, given a flat rate of 9d. per therm, to sell a large proportion of the output at a figure of round about 5d. to 6d. A certain amount of business at these prices is, however, desirable and profitable, given, of course, a reasonable margin of surplus manufacturing and distributing plant. With this latter proviso, special contracts are fully justified at these prices for large industrial and heating loads.

Although the Company has no regularized optional two-part tariff for domestic consumers, special tariffs to meet particular loads are offered under two-part contracts. The Author feels that it is very desirable to cultivate the " background " heating load, preferably in the form of central heating, and that in the larger homes there should be no hesitation in giving an attractive " all-in " tariff for heating, hot water supply, cooking, etc. where solid fuel (even though it may be coke) can be displaced and gas sales greatly increased accordingly. The eviction of solid fuel, from investigations which have been made, may easily result in trebling the gas consumption in the home and it is in such cases that special domestic contracts can be fully justified. The Company offers special contracts to domestic customers who are willing to take 1,000 therms or more per year for general purposes, including hot water supply and central heating.

Retail Sales

In dealing with the politics of selling, attention must be directed to the growing fallacy of measuring prosperity in terms of retail sales of apparatus. For some time past many Gas Undertakings, among them the Croydon Gas Company, have done all in their power, as part of their sales promotion programme, to cultivate the " customer-ownership " of apparatus. Trading in gas apparatus, however, is something which falls far short of the full and proper meaning of " marketing " as applied to the Gas Industry. A proper balance is wanted between what may be termed the " ironmongery " sales and the gas sales, since people with limited means are apt to economize in the use of gas when they have heavy hire-purchase dues to meet for apparatus. Marketing in the Gas Industry is a service function as well as a sales problem, and the ultimate effectiveness of any gas sales organization cannot be wholly measured in terms of apparatus sales, much of which is replacement business.

Future Progress

The time has arrived when progress can no longer be gauged merely by the sales and output of apparatus, any more than it is possible to live on past benefits conferred upon the community. Equally futile, in legislating for the future, are those negative arguments in favour of gas, whereby the strength of the Gas Industry is supposed to be clearly manifested by weak points brought out to expose the alleged insecure and difficult position confronting the Electricity Supply Industry, should it succeed in exploiting the domestic business too far.

Electricity is here to stay, and the arguments advanced against it on economic grounds usually find an uninterested audience, as is the case, too, when coal conservation and smoke abatement are used as fundamental reasons why the public should use gas in preference to electricity. Neither form of energy can hope to enjoy a monopoly except in isolated branches of lighting, heating and power.

Electricity and gas will progress side by side, and now that production methods have reached such a high degree of efficiency in the case of both forms of energy fortune will favour the industry which pays the greatest attention to the technical development of service.

The positive merits of gas service have to be expressed, and current achievements made more widely known. This, of course, is the function of advertising. Facilities must be provided whereby these achievements may be enjoyed by an evergrowing percentage of the population. This introduces commercial policy. Gas service has then to be translated into everyday practice, and this is where service counts for so much. While each Gas Undertaking must naturally decide on the commercial policy best fitted to its own local conditions, all have one thing in common: that in the exploitation of opportunities technical direction at the sales and service end will count enormously. It is the complement to any well-considered installation and gas-pricing programme. Low installation rates for apparatus, enabling people to acquire readily the use of gas apparatus, and promotional tariffs permitting the widest use of the apparatus, are merely beginnings to an end—stages one and two in development policy. Technical service is the third stage.

Satisfaction of the customer begins with advice. It is carried a stage further by supervision of installation work, and finally made permanent by supervision of district maintenance work. The right installation, properly looked after, is the keystone of success; and it is incumbent upon the Gas Industry, during this time of intensified competition, to investigate fully the technical strength of sales and service personnel.

APPENDIX 1

STATISTICS RELATING TO THE CROYDON GAS COMPANY

Capital:	
Authorized	£2,425,864
Issued and paid up	£2,327,486
Gas Sales:	
Gas sold during year 1937 ..	3,193,872,300 cu.ft. = 16,422,891 therms
Number of consumers:	
Ordinary	50,445
Prepayment	52,870
	103,315
Average consumption in therms:	
Per ordinary customer ..	195·87
Per prepayment customer ..	106·68
Per customer	150·23
Population served (approximately)	400,000
Miles of main	592
Number of consumers' orders dealt with during the year ..	209,452
Value of appliances sold during the year	£121,636
Personnel:	
Number of employees	1,350

APPENDIX 4

BOOSTING PLANT AND HOLDER STATIONS

Boosting Plant

The boosting plant at the Waddon Works consists of two Bryan Donkin Rateau turbo boosters, one being driven by a Terry and the other by a Brotherhood steam turbine, and a Waller booster driven by a 75 b.h.p. steam turbine. This plant is capable of discharging gas to the district at a maximum pressure of 40 in. w.g. The capacities of the boosters are 1½, 2 and 1 mill. cu.ft. per hr. respectively. There is also an electrically-driven Reavell rolling drum compressor, capable of delivering 40,000 cu.ft. of gas per hr. at a pressure of from 10 to 12 lb. per sq.in. This compressor is used for pumping gas through a high-pressure main to the Carshalton gasholder.

Carshalton Gasholder Station

The gasholder is a 1½ mill. cu.ft. capacity spiral-guided type built in a steel tank. The top lift is designed to give a pressure of 10 in.

The gas for this station is delivered direct from the Works at Waddon through a 6 in. steel main at an initial pressure of 5 to 10 lb. per sq.in.

Whyteleafe Gasholder Station

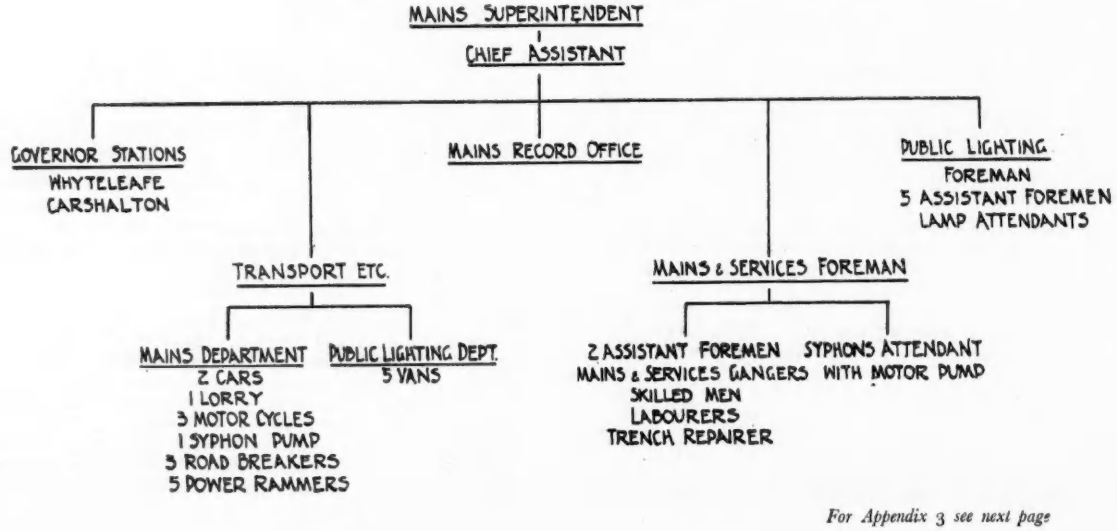
Whyteleafe gasholder station is similar in lay-out to the Carshalton station. The gas is delivered through a boosting main. There are two 18 in. Peebles governors, one controlling the supply to Caterham and Woldingham, and the other to Caterham-on-the-Hill and Warlingham. There are two electrically-driven compressors, of the Reavell rotary loose-blade type, having a capacity of 14,500 and 32,500 cu.ft. of gas per hr. respectively. These compressors are used for pumping gas to Oxted at times of heavy demand. There is one small gasholder with a capacity of 300,000 cu.ft.

Oxted Gasholder Station

This station is the original Works of the Oxted and Limpsfield Gas Company, which was taken over by the Croydon Gas Company in 1931. There are two gasholders of 150,000 and 60,000 cu.ft. capacity respectively. The governor house has been rebuilt to accommodate a 14 in. governor.

APPENDIX 2

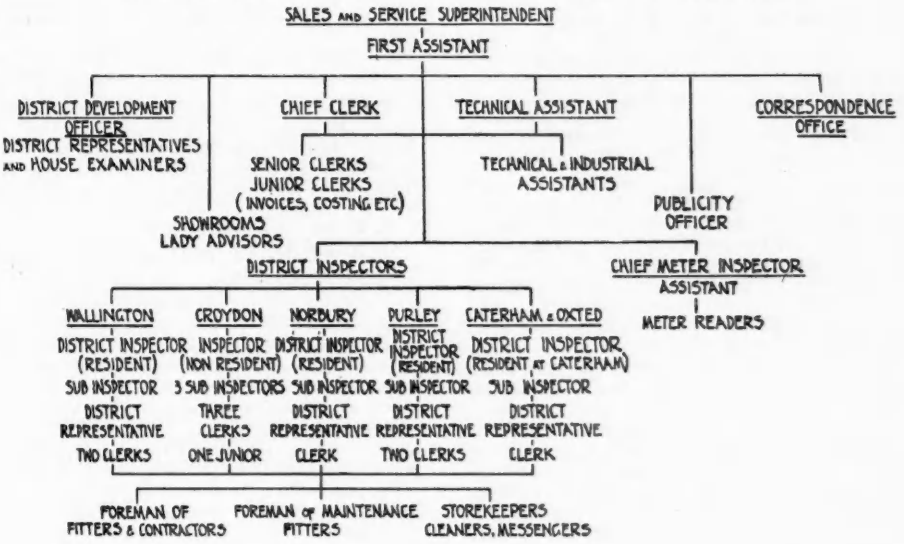
PERSONNEL OF DISTRIBUTION DEPARTMENT



For Appendix 3 see next page

APPENDIX 3

PERSONNEL OF SALES AND SERVICE DEPARTMENT



APPENDIX 5

SPECIMEN BUILDING SHEET

C.G.C. BUILDING SHEET. Date.....

Road..... Location.....

Number of Houses..... Date commenced .....

Architect

Owner .....

.....

Builder .....

.....

If main required give following particulars :—

Length required.....

„ of service pipe on private property.....

Points required.....

Orders to lay service or services (To be filled in by Head Office when orders are made)

Order No.	A	A	A	A	A .....
Date..	.....	.....	.....	.....	.....
No. of houses covered by each order	.....	.....	.....	.....	.....
Charge per house (when stated) for service only ..	.....	.....	.....	.....	.....

Who is carcassing ? State whether Builder or Company.....

Orders to carcass (To be filled in by Head Office when orders are made)

Points provided : Lights ..	.....	.....	.....	.....	.....
Fires ..	.....	.....	.....	.....	.....
Cooker ..	.....	.....	.....	.....	.....
Copper ..	.....	.....	.....	.....	.....
Geyser ..	.....	.....	.....	.....	.....
Boiler ..	.....	.....	.....	.....	.....
Order No.	S	S	S	S	S .....
Date..	.....	.....	.....	.....	.....
No. of houses covered by each order	.....	.....	.....	.....	.....
Charge per house carcassing only	s. d.	s. d.	s. d.	s. d.	s. d.

Continued at foot of next column

APPENDIX 6

PERSONNEL OF WALLINGTON DEPOT

(CUSTOMERS SERVED BY THIS DEPOT : 32,000)

District Inspector (resident)	1
Sub-Inspector	1
District Representative	1
Inspector's clerks	2
Fitting foremen	3
Lady Demonstrator	1
House Examiners	3
Storekeeper and assistants	2
Fitters	16
Fitters' assistants	13
Complaint hands	3
Burner maintenance men	5
Gas fire maintenance men	3
Water heater maintenance men ...	5
Cooker cleaners	2
Office cleaners	2
Messenger	1
	64

Please give particulars below if Builder is supplying any gas appliances or coke boiler : .....

.....

Works Control

Communication No. 185

by

W. HAWKYARD, M.Inst.Gas E., M.I.Chem.E.

(Works Engineer, Willoughby Lane Works, Tottenham and District Gas Company)

DESCRIPTION OF WORKS

The carbonizing plant consists of one continuous vertical retort house and one intermittent vertical retort house.

Continuous Vertical Retort House

This house has two benches of 28 retorts each erected by the Woodall-Duckham Company. These are downwardly heated with end producers and have a capacity of 5½ mill. cu.ft. per day, carbonizing 360 tons of coal. The original Woodall-Duckham settings were erected in 1917. The house was re-set in 1928 and since then each bench has been cold patched twice.

This section has the usual ancillary plant, the only comparatively modern part of which being two Connersville exhausters, each with a capacity of 9 mill. cu.ft. per day, coupled to Belliss and Morcom steam engines. The condensing plant consists of two units of water-cooled and one unit of atmospheric condensers. The gas is washed by means of Livesey washers and two centrifugal washers made by Kirkham, Hulett and Chandler, Limited. A third scrubber is being erected this year. This is a 3 mill. cu.ft. per day static washer by W. C. Holmes and Company, Limited.

The purifiers are of reinforced concrete, comprising 10 boxes, each measuring 42 ft. × 28 ft. The waste gases from the setting pass through two waste heat boilers of the Babcock and Wilcox type. The coke from this house is screened on Drake's cascade screens and, if required, cutting is effected by means of Phœnix Supply Company's coke cutters.

Intermittent Vertical Retort House

The description of this house will be given in greater detail owing to its being more modern than the continuous vertical retort house.

The intermittent vertical retort house was built in 1933 by the Woodall-Duckham Company on the site of the old horizontal house which made rather less than 2 mill. cu.ft. of gas per day. There are eight settings, each of six ovens, arranged in two benches, with space for two additional settings, one at the end of each bench; it is proposed to add these two settings, one in 1938 and one in 1939, when the ovens are let down for cold pointing.

The house has a nominal capacity of 4,800,000 cu.ft. of gas, but it has worked so successfully that its normal daily production is 5½ mill. cu.ft. and on some occasions has exceeded 6 mill. Each oven takes a charge of 3¾ tons of coal and the most economical charging cycle has been found to be 11 hours.

Coal is unloaded by means of a rotary wagon tipper into the coal crushers and is conveyed to overhead hoppers by means of elevators and conveyors having a capacity of 80 tons per hr. The crushers, elevators and conveyors are in duplicate. The coke is discharged into skips which are drawn to a quenching tower. The method of haulage is worthy of note, since it is effected by chains. This system has been found to be very satisfactory and the maintenance costs have been very low. After partial quenching the coke is transported to an inclined coke wharf, where it is allowed to cool and drain. Experience has shown that the coke has been too dry and it has been necessary to add a further quantity of water to keep down the dust. Coke is discharged at the bottom of this wharf into skip hoists which elevate coke to the hoppers of the screening plant.

Coke Screening Plant

The coke screening plant is equipped throughout with Strachan and Henshaw's C.C.L. screens. The plant is in duplicate, each section having a nominal capacity of 25 tons per hr. Here, as in No. 3 retort house, the coke cutters are by the Phœnix Supply Company.

It may be of interest to describe in some detail the processing of the coke on this plant. The coke, as delivered from the quenching wharf, first passes over a scalping screen and all material under 1¾ in. is conveyed on to a secondary screening plant by means of a belt conveyor in which it is screened into three further sizes:

1. Boiler fuel—through ½ in.
2. Breeze for the pads at the bottom of the chambers—through ¾ in.
3. Producer fuel—remainder.

The material over 1¾ in. either falls into a hopper or alternatively passes through coke cutters and thence to the main screens where it is graded into the standard sizes fixed by the London and Counties Coke Association. C.C.L. debreezing screens and Belle Isle weighing machines are employed for bagging the coke. The coke loading is greatly facilitated by the lay-out of the loading platform. This platform is at the same height as the standard lorry, whilst the portion where the coke is weighed is raised so that no lifting of the loaded sack is necessary, and it is simply picked up and deposited on the lorry.

Ancillary Plant

The waste gases pass through two waste heat boilers and in this section current is generated by duplicate 200 kw. Lancashire dynamo generators driven by Belliss and Morcom engines. There are two Connersville exhausters which, with a nominal capacity of 9 mill. cu.ft. per day, are driven by Bellis and Morcom engines. The condensing plant consists of three units of Holmes super condensers. When this plant was originally put to work two condensers were provided of the Holmes super type. These condensers were intended to work on well water, the first having the water re-circulated over a water tower and the second being fed with well water, part of which water served as make-up for the first condenser.

After a short time the efficiency of condensation fell away very rapidly. It was found that this falling away in performance was due to a deposition of scale on the tubes, although the water temperature rarely exceeded the 140° F. which had been accepted as a minimum temperature for scale formation in a close circuit. This trouble made it necessary to review the cooling system. As a temporary expedient the tubes were de-scaled by circulating a dilute solution of hydrochloric acid containing bone size as an inhibitor. The final strength of this solution, which was arrived at after making many enquiries, was 0·25 per cent. hydrochloric acid and 0·025 per cent. bone size. This had the effect of partially removing the scale, together with the weed and slime. A second treatment was successful. The maximum thickness of the scale deposit in the condensers was found to be about $\frac{3}{32}$ in., but since the acid had to be circulated over the heavily-scaled cooling tower as well as the condensers the total consumption of hydrochloric acid was 15 tons. The method adopted to overcome these troubles was as follows:

It was obvious that softened water would have to be used and in order to save water a third condenser was installed. The first condenser is using circulated softened water and the second and third condensers in series are also fed with softened water. The warm water from the second and third condensers is sent to the feed water heaters for boiler use and a separate supply of cold, softened water is used for make-up for the circulatory system.

The gas, on its way to the Livesey washers and Holmes rotary scrubbers, is treated in a high tension electrostatic detarrer by Whessoe/Woodall-Duckham. The purifiers for this plant consist of 15 boxes, each measuring 25 ft. × 32 ft., the gas being divided into three parallel streams. The gas

is measured by two Connersville meters working in parallel, each having a capacity of 4 mill. cu.ft. per day.

Carburetted Water Gas Plant

This plant consists of five sets, three of which are arranged for back-run working and each has a daily capacity of 1½ mill. cu.ft. of gas. The other two sets are not back-run units but are fitted with a common waste heat boiler. Their daily capacity is 1¼ mill. cu.ft. These sets are hand operated and call for no special mention.

The water gas plant is now due for re-modelling and a commencement has been made by removing the exhausters and blowers to one common building. It is anticipated that, in the very near future, the old sets will be gradually replaced by the modern type of mechanically-operated controls and self-clinkering grates.

The gas passes through the usual water gas condensers coupled to an atmospheric cooler, and from the atmospheric cooler to the exhausters and to an electric detarrer, similar to the one which is working on the intermittent vertical gas section. The gas then passes through a set of six cast iron boxes.

COAL SUPPLIES

As a commencement it is proposed to deal with the most important commodity used in the Gas Works, namely, coal, and show the methods adopted to obtain the most satisfactory results from all points.

Selection of Coal

The Tottenham and District Gas Company has, for a number of years, given very careful attention to the selection of coals which are used. This selection must be viewed from two angles:

1. The economical manufacture of gas.
2. The production of a coke suitable for use in domestic grates and boilers and also for general industrial appliances.

With the development of the coke fire particularly, it has been found that a coal which gives the maximum gaseous yield often produces a coke which is totally unsuited for burning on a domestic coke grate. In consequence, further purchases of this class of coal have had to be discontinued, thereby sacrificing gaseous therms in order to maintain a supply of satisfactory solid smokeless fuel. The working up of a market for solid smokeless fuel has thus altered very considerably the problems connected with coal purchases and the subsequent quality of these coals. For some years now it has been the policy of the Company to purchase coals on an ash and moisture guarantee basis. In the case of Durham coals the total is 9·5 per cent. and for South Yorkshire and Derbyshire coals 10·0 per cent. Latterly all the coals purchased have been either washed or dry cleaned. Besides giving a cleaner coke, the effects of this can be seen in the working of the setting, less dust being carried forward to the flues, thus minimizing very considerably the fluxing of this dust which causes so much trouble in many cases.

Testing of Coal

In deciding the classes of coal to be purchased full-scale tests are carried out on a quantity of about 1,000 to 1,500 tons. This quantity is sufficient to give at least a three days' test on the continuous vertical retort section. The results are carefully recorded as to gas production and working, and as to the suitability of the coke for its ultimate use. The testing of the coals is made as consistent as possible by fixing a calorific value to which to work. This may be open to objection, but it has been found to be a convenient basis, as it will also give a very useful criterion as to the steaming properties of the coke. The travel of the coal is very carefully noted in order to ensure that no difficulties are encountered which may lead to trouble and increased labour charges.

Testing of Coke

The gas and coke yields are measured and screening tests are carried out on the coke to ascertain its selling value. The cost per therm of the gas is then calculated.

An examination of the coke is next made. The standard for this coke is that of a coke made from a Yorkshire coal which has been found to be very suitable for domestic purposes. The coke is tested in coke grates and domestic boilers for its burning properties. The grates and boilers used are standard, such as are used in the Company's area. Coke is fed to the empty grate and the amount required to fill the grate noted. The quantity of gas required for ignition is recorded and also the time taken to obtain a hot fire. The fire is then kept alight for a specified time and the weight of the coke burnt is measured. Afterwards the fire is allowed to die out and the ash and unburnt material weighed. The "bats" are separated from this unburnt material and also weighed.

A boiler test is also carried out on the Ideal No. 0 boiler. The results are tabulated as shown in Tables 1 and 2.

Table 1.—*Test of Size III Coke from No. 3 Retort House, in Domestic Boiler (Ideal No. 0)*

2·2 lb. of wood used to ignite.

	Results of Test.	Standard.
1	2	3
Time to raise water to 212° F. (154° F. rise), min.	93	100
Total coke burnt, lb.	50·8	—
Moisture in coke, lb.	3·8	—
" " " per cent.	7·5	—
Total dry coke burnt, lb.	47·0	—
Fine ash recovered, lb.	3·23	—
" " per cent.	6·85	—
Burnt "bats" found, lb.	0·40	—
" " per cent.	0·85	0·5
Clinker formed, lb.	0·44	—
" " per cent.	0·90	—
Fine ash, burnt "bats" and clinker, lb.	4·07	—
" " " " per cent.	8·60	8·5
1 cu.ft. of this coke, corrected to 7·5 per cent. moisture, weighs, lb.	24·6	21·9
This fire could be kept alight:		
With hopper, hr.	17	16
Without hopper, hr.	13	12

Table 2.—*Report of Coke Fire Test*

Date:
Coke Used:
Type of Grate:
Coke Analysis: Moisture 8·5 per cent.
Ash (dry basis) 9·9 per cent.
Volatile matter (dry basis) 1·9 per cent.

	Test.	Standard.
1	2	3
Coke required to fill grate, lb.	10·1	6·6
Gas for ignition, cu.ft.	23·0	9·0
Time for ignition, min.	23·0	12·0
Total time to produce hot fire, min.	60·0	50·0
Coke required to maintain hot fire for 7 hr., lb.	16·5	17·7
Moisture in coke (3·5 per cent.), lb.	1·4	0·9
Dry coke required for hot fire for 7 hr., lb.	15·1	16·8
Consumption of dry coke per hr., lb.	2·16	2·4
Total coke burnt during test, lb.	26·6	24·3
Moisture in coke (8·5 per cent.), lb.	2·2	1·2
Total dry coke burnt, lb.	24·4	23·1
Fine ash recovered, lb.	1·87	1·38
Fine ash, percentage of dry coke burnt	7·9	6·0
Burnt "bats" found, lb.	0·02	0·05
Burnt "bats," percentage of dry coke burnt	0·1	0·2
Fine ash and burnt "bats," per cent.	8·0	6·2
Cinders left in grate, lb.	3·3	1·64
Bulk density in lb. per cu.ft., corrected to 7·5 per cent. moisture, lb.	30·5	22·1

Coal Sampling

The supplies of coal coming forward are continuously tested and particular attention is given to the most important question of sampling. Each retort house has its own samplers and appliances and the following is the method adopted:

According to British Standard Specification No. 420-1931 the coal used here falls into Class A and the weights of sample taken conform to this standard. The minimum weight of sample required to obtain any degree of accuracy is 36 kg. for consignments over 50 tons and 18 kg. for consignments under 50 tons obtained in a minimum of 20 increments, but the figure of 36 kg. is adopted as standard. At Tottenham the coal elevated to each retort house is approximately 360 tons per day and consists of consign-

ments from several collieries. The sample taken from the discharge of a push plate conveyor to the retort house hopper weighs approximately 20 kg. per truck of coal taken in increments of 2 kg. The gross sample is mixed and reduced by coning and quartering to 5 kg., which is crushed to ½ in., roughly air-dried, and afterwards ground to 60-mesh; a portion of this ground sample is taken to the laboratory for analysis. The operation of coning and quartering is carried out as follows:

A cone is formed by depositing each sample on top of the preceding one, care being taken to pour each shovelful exactly on to the point of the cone so that the sample falls evenly round it. The conical mass is then flattened out to about 4 in. thickness, divided into four quarters, and the two opposite quarters rejected. The remaining quarters are mixed and the operation repeated until the sample is reduced to 5 kg.

Moisture Test

For determining the " moisture as received " a separate sample is taken from the trucks as they are unloaded. The general sample taken would not be acceptable owing to the loss of moisture which would take place during transit from the crusher to the hoppers and also during the time taken to quarter the larger sample. The moisture sample is approximately 5 kg. per truck. This is quickly mixed, coned and quartered and reduced to 5 kg. without grinding, and then transferred to a container with a close-fitting lid which is immediately taken to the laboratory. This sample is at once dealt with and 1 kg. is weighed out and placed in the drying oven which is maintained at a temperature of 106° C. by a thermostat control.

Gray-King Coal Assay

Each coal is regularly tested on the Gray-King apparatus. This is found to be a very useful test and at once demonstrates when inferior qualities of coal are being sent in, which the ordinary ash and moisture tests would not reveal. Results in the retort house may be falling away and no indication of the reason be apparent in the routine testing. The Gray-King test will show at once if the coal is deteriorating due to variations in the coal substance, quite apart from the ash and moisture content. The results obtained from this apparatus are comparable with large-scale straight carbonizing practice, and with experience a very accurate forecast of the working of a coal can be made; also from the examination of the residual coke a good idea of its quality can be formed.

One particular point on which stress should be laid is that this testing should always be made by the same chemist in order that the results may be strictly comparable. Two workers, equally reliable, would get slightly varying results owing to minor differences of procedure, and although these differences may be disclosed when the results are set out side by side, there would be no difference if each man's results were evaluated separately and compared with his own results obtained from a standard coal. The results are tabulated as shown, and, further, the rate of gas evolution is graphed. This graph is a very good criterion of the quality of the coal for gas making purposes. Examples of such a graph, showing a good coal is illustrated. (Figure 1.)

General Commodities

So far as general running stores are concerned ordinary routine testing is carried out and this does not call for any special comment.

CONTROL OF PLANT

General Maintenance

Each of the two retort houses has its own Shift Foreman and a day-time Section Chemist who works in collaboration with the Shift Superintendent. There is one Heats Foreman who is responsible for the heats in both houses and he has two junior assistants who take temperatures. Two assistants are not really necessary but it is thought that the work of using a disappearing filament pyrometer should be halved, in order not to strain the eyes unnecessarily.

Coal: "B" (Figure 1).			
Grade:			
Date of Sample:			
Date of Test:			
Proximate Analysis of Coal:			
Moisture (as received)	2·5	per cent.	
Moisture (air dried)	1·0	per cent.	
Ash (wet basis)	2·4	per cent.	
Volatile Matter (wet basis) ..	34·8	per cent.	
Coal used for Test (air dried) ..	20·00	g.	
Coke produced	14·40	g.	14·40 cwt. per ton
Gas produced:			
Volume at 15° C. and 30 in. ..	7,320	c.c.	13,130 cu.ft. per ton
Analysis of Gas, including air originally in train:			
$CO_2 + H_2S$	1·8	per cent.	
O_2	0·6	per cent.	
Illuminants	4·0	per cent.	
CO	5·6	per cent.	
H_2	53·8	per cent.	
C_2H_6	—		
CH_4	29·0	per cent.	
N_2	5·2	per cent.	(Residual —)
Calculated Calorific Value ..	586	B.Th.U. gross	
Therms per ton (air dried) ..	77·0		
„ „ „ (dry and ash free)	79·7		
„ „ „ (as received) ..	75·8		
Specific Gravity	0·41	(air = 1)	
Density	0·505	(g. per litre)	
Tar produced	0·97	g.	9·2 gal. per ton
Liquor produced	1·15	c.c.	12·9 gal. per ton
Ammonia produced	—	g.	— lb. S/Ammonia per ton
Percentage yields:			
Coke	72·00		
Gas (— Air)	17·00		
Tar	4·85		
Liquor	5·75		
	99·60		

ASSAY 3.—*Coal "B".*

The rest of their time is spent in other useful work in the retort house.

The care and maintenance of the retort settings is considered to be of paramount importance and from the date of lighting up to the end of their life they are not forced beyond the point of reasonable temperatures. When a new house is built no high guarantee figures are demanded, as it is obvious that the plant can be permanently injured in the first few weeks of its life if efforts are made to obtain high results. With experience of the bricks used in the construction there need be no difficulty in arriving at temperature conditions which will conduce to an economical and useful life of the setting.

The policy at Tottenham is to subject the carbonizing plant to as few changes as possible, and, once a unit has been put to work, not to shut it down except in the normal period of repair or re-setting. This has been achieved by working out a programme so that the carbonizing plant is in four sections. By this means one quarter of the plant is down every summer for either patching or re-setting. This arrangement has worked very effectively in the particular case of the Tottenham and District Gas Company, possibly because of the fortunate size of the units, since one-quarter of the plant is sufficient drop for the summer when allowance is made for the balancing effect of carburetted water gas.

There are many factors which are contributory to the life of a setting, some of which are very controversial, and only those are given which are considered to be the main points in the working of vertical retorts.

Purchase of Suitable Coal

In the case of continuous vertical retorts the coal should be of such a nature that excessive rodding is not required.

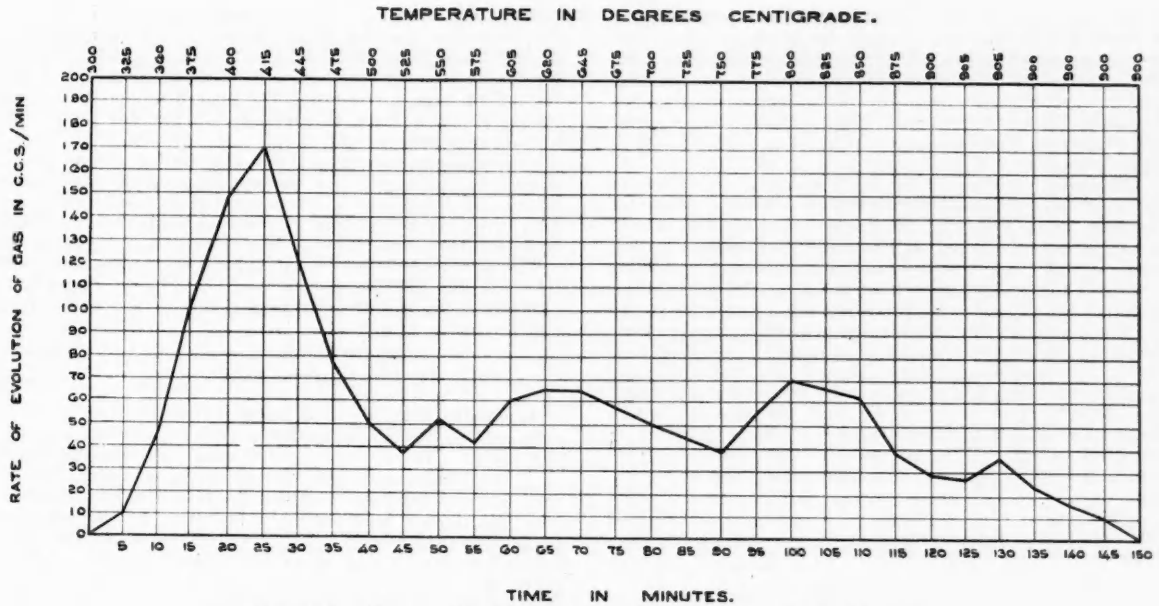


FIGURE 1.—*Typical Results of Gray-King Coal Assays : Coal " B ".*

because, if a coal requires a considerable amount of rodding, it is practically certain that some damage will be done to the brickwork by means of the rods. In the case of intermittent vertical retorts it is advisable to have a coal which does not swell too much, otherwise excessive stresses are put on the brickwork and there is the danger of " hangers ". The question of producer fuel is a very important one. It is not considered good policy to feed producers with either breeze or a coke containing a good proportion of breeze. The dust will almost certainly find its way into the flues and cause trouble, or else build up on top of the clinker formed in the higher region of the producers, whence it would be very difficult to dislodge.

REGULAR WORKING

Working should be as regular as possible, avoiding shut-downs unless absolutely necessary. If a shut-down cannot be avoided, however, excessive changes of temperature should not be allowed.

SCURFING

Too much care cannot be given to this necessary operation and it must never be hurried. The scurf should be allowed to burn off quietly so that there are no violent temperature variations. If the retort is scurfed rapidly the scurf will flake off the walls and this flaking is practically certain to remove with it some of the brickwork face, or drag out some of the jointing material. On no account should the use of bars be allowed. Whilst the retorts are off for scurfing it is the practice to examine the brickwork carefully for leakages. In the case of the continuous vertical retorts this is a simple matter. When the scurf has burnt off, the combustion chamber is put under pressure, when holes and fissures are immediately seen by the flame which shows in the retort. If the hole is large it is first shot by means of the E.B. Gun, using a special mixture which is recommended by the builders. It is afterwards sprayed by means of a pressure spraying machine. These methods have proved to be very efficacious and certainly add to the life of the setting.

In the case of the intermittent vertical section the method of scurfing is different. When the house was originally put to work it was suggested that a method of continuous scurfing should be used. A suggested time was 20 min. for each retort at the end of every discharge and this has been found to be very satisfactory. With rare exceptions this time has been found sufficient for burning off any scurf formed. With regard to patching and pointing, as previously mentioned, these retorts have only worked during five winters and the working has been so good that no real experience has been obtained. However, as a matter of routine, the tops are swabbed by means of an asbestos brush dipped in a mixture supplied by the builders.

For patching and washing work no experimental cements or mixtures are used, as it is considered much safer to use the mixtures recommended by the builders, who have the advantage of their wide experience of brickwork and the most suitable jointing for it.

GAS MANUFACTURE.

During the past few years the questions arising out of gas manufacture have been settled more or less by the economic conditions prevailing. Benzole washing, high coke prices and increase in the price of carburetting oil have had a very marked effect on gas production and methods have had to be adjusted to suit these new conditions.

In the case of the Tottenham and District Gas Company, where a substantial proportion of coal gas is available, manufacture has been so arranged that the minimum quantity of carburetted water gas has been made. This policy is obvious when the costs of manufacture are viewed. The net manufacturing costs of the three gases into holders, i.e. after allowing for residuals, are as follows:

Intermittent vertical retorts	1·87d. per therm
Continuous vertical retorts	2·19d. ,,
Carburetted water gas	3·85d. ,,
Total gas made	2·21d. ,,

These are the actual figures for the year 1937.

From the above statement it will be seen that carburetted water gas could not be manufactured economically with the out-of-date plant available. Under present conditions the arrangement is to make as high a calorific value as possible in the intermittent section, to permit extraction of benzole and to maintain a sufficiently high final calorific value after benzole extraction to counteract the low calorific value of the continuous vertical gas and any carburetted water gas made. This is necessary because the continuous vertical section will not make a high calorific value gas and when back-run sets are being used on the carburetted water gas plant, although these give a higher gas yield, the maximum economic calorific value does not exceed 500.

WORKING CONTROL OF INTERMITTENT VERTICAL HOUSE

The specification for this house stated that its nominal capacity was 4,800,000 cu.ft. of gas per day. The house was

originally started on 14-hr. charging periods but experience showed that this period could be safely reduced and the working cycle is now 10 hr. 40 min., with a scurfing period of about 20 min. at the end of every draw, making a complete cycle of 11 hr. The coals carbonized can be said roughly to be 50 per cent. Durham and 50 per cent. South Yorkshire, both classes of coal being either washed or dry cleaned.

In the control of the setting the temperatures are taken daily in order to maintain regularity of working. Periodical testing of the flues and producer gas is carried out at frequent intervals. Some improvement has been effected by studying the depth of the cracking zone at the top of the retort and, by experiment, it has been found that in this particular case it was definitely advantageous to increase the depth slightly. Steaming is restricted to the last two hours, because the calorific value aimed at is 540 to 545 B.Th.U. The tie rods of these benches are water-cooled, softened water being used, and in order to ascertain if there is any deposition of scale in the rods the flow of water through them is measured regularly. A standard nozzle is fitted to the outlet and the volume of water measured over a definite period; in this way any blocking-up can be ascertained.

Whessoe/Woodall-Duckham Detarrers

Description

The plant comprises a 150 milliamp. English Electric Company high tension D.C. generator set, with a maximum voltage of 30,000, feeding two detarrers. One of these is a 6 mill. cu.ft. unit treating carburetted water gas, and the other a 9 mill. cu.ft. unit, treating the gas from the intermittent vertical chambers. The treaters operate at different voltages, usually about 27 kV for the intermittent vertical chamber unit and 21 to 23 kV for the carburetted water gas unit, and the voltage is balanced by a bank of resistance rods operated by pole switches. Each of the two units of the generating set, which are self-exciting, has two separate H.T. windings which are brought out to two commutators at either end. These commutators are connected in series by an internal connexion. The maximum voltage is thus built up in four stages, each of 7,500 V.

To protect the generator windings from electrical surges produced by flash-over in the treaters, special resistance rods are connected across the H.T. commutators and an earthed condenser is connected through a resistance rod to the H.T. bus-bar. Each generator frame is maintained at a potential midway between the extremes of the generator and is insulated from the bed plate by porcelain supports and from its neighbouring generator or motor by ebonite couplings. The driving motor is shunt-wound and driven by the Works D.C. supply. The motor starter and speed regulator are of normal construction, the starter being provided with time-lag overload and no-volt releases.

The positive side of the H.T. circuit is connected to earth through a shunted milliammeter and an overload relay with a time lag of about 40 sec. This milliammeter indicates the total output of the set, which must be divided between the two treaters. The fairly long time lag of the overload relay prevents shut-down by an ordinary flash-over in either treater.

Horn and light signals are provided to give warning to the exhauster man of a generator shut-down.

The negative side of the H.T. circuit is connected through a ⅜ in. copper rod to the treater cable switches and to the resistance rods which are used to balance the treater voltages. The cable switches can be connected in three positions:

1. On, resistance rods short-circuited.
2. Off, cable earthed.
3. On, resistance rods in circuit.

Each resistance rod has its own pole-operated switch. Shunted milliammeters connected to the treater cables indicate the amount of current passing to each treater and enable the voltages to be balanced by means of the resistance rods.

A system of Castell interlocks makes it impossible to open the inspection doors of either treater unless the main switch of that treater is off and locked in the earthed position. Similar interlocks make it impossible to open the door of the safety cage surrounding the generator and switch-gear unless the generator is earthed and the earthing switch locked in position.

The treaters consist of inlet and outlet chambers connected by vertical tubes containing centrally suspended alloy steel wires which are connected to the H.T. system. The wires are hung from a framework which is suspended from a vitreosil insulator. The cable end is sealed in oil.

The operation of the plant is extremely simple and free from trouble and the efficiency of tar removal is above the guaranteed figures. The original precipitation wires are all still in use.

Cleaning and Maintenance

A regular cleaning and maintenance routine is rigidly adhered to. Every week the generator is shut down for ten minutes for a rapid examination and for removal of dust from the insulators. On alternate cleaning days the shut-down is extended to three hours. The treater insulators are cleaned with benzole, the floor of the generator house is scrubbed and dried, and the generators and insulators examined and thoroughly cleaned. Twice a year the plant is shut down for two days while the treaters are steamed out, washed down and inspected. Finally, owing to the slow production of carbon in the sealing oil of the cable lead-in chambers of the treaters, it has been found advisable to change this oil every two years. It has been deemed advisable to cover the windows with a fairly stout wire mesh screen, for protection to the generators inside the building.

Operation of Detarrer

The first of the two Whessoe/Woodall-Duckham electro detarrers was put to work in 1933. It was so arranged that it could be used either on the intermittent vertical gas stream or on the carburetted water gas stream. The results were so successful that another unit was purchased in 1936, so that now the intermittent vertical gas and the carburetted water gas section each has its own detarrer.

The positioning of the detarrer, especially in a coal gas stream, requires careful consideration. In the case of the intermittent vertical coal gas stream it is placed immediately after the exhausters. If it is placed later in the purification system trouble will occur owing to the smaller quantity of tar to be removed, which will thicken and refuse to run and cause flashing-back.

The efficiency of the tar extractor is shown immediately it is shut down for cleaning or overhaul. Even after 20 minutes of the shut-down an increase of pressure at the inlet to purifiers is noticed. A theory put forward to account for this rise of pressure is that it is due to the formation of a light oil film on top of the oxide. This is supported by the fact that traces of this oil can be found in the syphons at the inlet to the purifiers. In all probability this film resinifies, which would account for the obstruction to the gas passage.

In the water gas section the working has been so successful that since its installation only two boxes were changed in 1936 and one in 1937. This is not a true criterion of its value in the water gas section of purifiers, as the boxes were filled with very old oxide and were oil-logged, but it is anticipated that when the boxes are re-filled with reasonable quality oxide the number of changes will be practically nil.

Working Costs and Performance

With the present generator, limited to a maximum output of 150 milliamps. and a safe maximum for continuous running of 140 milliamps., the full capacity of both treaters together could not be used at maximum precipitation efficiency, since this would require about 170 milliamps. The existing generator is, however, adequate for the present maximum load.

The following are typical performance figures for the two treaters:

TABLE 3.—*Performance of Detarrers*

	Intermittent Vertical Chambers.	Carburetted Water Gas.	
		High Load.	Low Load
1	2	3	4
Maximum rated daily capacity, mill. cu.ft.	9	6	6
Daily throughput during test, mill. cu.ft.	5¾	5	2½
*Tar fog in inlet gas, gr. per 100 cu.ft.	310	290	420
Tar fog in outlet gas, gr. per 100 cu.ft.	1·8	1·0	<0·5

* Tar fog content depends on rate of oiling

The following is a comparison of working costs, at maximum generator output, with the average cost for the year 1937:

TABLE 4.—*Comparison of Costs of Detarrers*

Annual Costs for 1937

Capital Charges — 15 per cent. of £4,000	£600 : 0 : 0
Repairs and Maintenance	£46 : 6 : 0
Supervision and Testing	£26 : 0 : 0

	At Maximum Generator Output.	Average for 1937.
1	2	3
Volume of gas, mill. cu.ft. per day:		
Carburetted water gas	3·75	1·46
Intermittent vertical chambers	5·75	5·50
Total	9·50	6·96
H.T. current, mA	140	120
L.T. current input, kW	6·69	5·24
kWh per mill. cu.ft.	16·9	18·0
Costs per mill. cu.ft:	s. d.	s. d.
Capital cost	3 5·3	4 8·6
Repairs and maintenance, etc.	5·0	6·8
Power, at 0·6 pence per unit	10·1	10·8
Total cost	4 8·4	6 2·2

PURIFICATION

The purification plant does not call for any special comment and the boxes are of the ordinary concrete type working with oxide. Experiments are being conducted with oxide manufactured in the Works and, so far, the results are considered to be pleasing. It is, however, deemed too early at present to give any definite information on this subject. In the working of the boxes the greatest possible care is taken to admit as little air as possible, because it will be readily seen that when working on a declared calorific value of 500 B.Th.U. ½ per cent. of oxygen will mean a reduction in calorific value of 10 B.Th.U., whilst if 1 per cent. of oxygen is admitted the loss in calorific value would be equal to at least 20 B.Th.U This position obviously may mean that the benzole stripping must be reduced or stopped according to the rate of air admission, in order to maintain the declared calorific value.

WATER

There are three separate water supplies on the Works:

1. Brook water, drawn from a stream on the Works boundary.
2. Well water, pumped from three boreholes driven into the chalk.
3. Town water.

The brook water, which consists largely of purified sewage effluent and surface water, varies very widely in quality. It is used for coke quenching, for cooling sprays on atmospheric condensers and for maintaining the seals on water gas washers. The used water is returned to the brook after cooling, settlement and filtration.

The well water is pure, has a fairly constant hardness of 9 gr. per gal. temporary and 6 gr. per gal. permanent, and its temperature, when freshly won, varies by only a degree or two from 52° F. at all seasons of the year. It is used for cooling where exceptionally cold water is required, for boiler feed water and for general Works purposes.

Town water is used in the Works canteens and lobbies and for certain emergency supplies.

Cold well water is used on the calcium chloride coolers of the gas drying plant and on the crude benzole and naphtha condensers of the benzole recovery plant. The slightly warm water from the coolers is pumped to a water tower at the north end of the Works, where it is mixed with any unused water coming directly from the wells. This water is used on liquor coolers and the gas condensers at the north end of the Works, and is also used to supply a Boby Azed base exchange softener which feeds the boilers at the north end of the Works.

At the south end of the Works, cold, freshly-won well water is pumped through two Boby Greensand softeners to supply the make-up water for the intermittent vertical gas condensers. The warm water, together with that from the water-cooled tie-bars of the retort benches, is fed to the boilers at the south end of the Works.

All boilers have open feed water heaters, in which the water is heated to 200° F. by exhaust steam. In this way most of the dissolved carbon dioxide and oxygen is removed and corrosion troubles reduced to negligible proportions. The concentration of solids in the boiler waters is maintained at 250 to 300 parts per 100,000 (170 to 210 gr. per gal.) by continuous blow-down.

Considerable trouble has been experienced with one of the wells, the borehole of which is infected with iron bacteria. The bacterial filaments are filtered out by the softeners and form an uneven layer on the surface of the zeolite, causing irregular distribution of the water through the softener beds. Attempts to sterilize the borehole proved ineffective, but the growth is now controlled fairly successfully by continuous chlorination of the water at the well head. The dead bacteria still collect in the softeners, but the layer does not adhere to the softener bed and is easily removed by backwashing. A Wallace and Tiernan chlorinator is used, and the dose is regulated to maintain a free chlorine content of 0·2 part per mill. in the water at the softener inlet. The chlorine consumption is about 0·5 parts per mill. of water raised.

GAS DRYING AND BENZOLE RECOVERY

The installation of the Dri-gas and naphthalene washing plant was described by H. C. Smith in his Presidential Address to the Southern Association of Gas Engineers and Managers in 1931, but perhaps it will not be out of place if a summary is given, as, since that date, the benzole washing plant has been substantially increased.

Gas Dehydration

Gas dehydration, together with naphthalene extraction, was commenced at the Willoughby Lane Works in October, 1929, although a partial removal of naphthalene had been previously achieved by oil scrubbers packed with wood wool.

Before the installation of the drying plant, a thorough survey was made of ground temperatures and of dew points of the gas at various places on the district, and Figure 2 shows the results obtained. The purpose of this survey was to give some guide as to the degree of drying desirable at different times of the year and the readings were continued after the plant was put into operation. The lines on Figure 2, indicating the dew points of the gas, show clearly the excellent results attained.

Various considerations led to the adoption of the Holmes "Dri-gas" system, and two units were laid down in parallel, each having a maximum daily capacity of 8 mill. cu.ft. Each consists of a pair of brush washers through which the gas passes in succession, the first removing the water vapour by means of calcium chloride solution, while the second removes the naphthalene by solution in gas oil. A chloride circulation of about 9,000 to 10,000 gal. per hr. is maintained through the two washers, and a portion of the solution is by-passed over exhaust steam-heated rack evaporators to remove the water absorbed. The regenerated solution is cooled in rack coolers on its

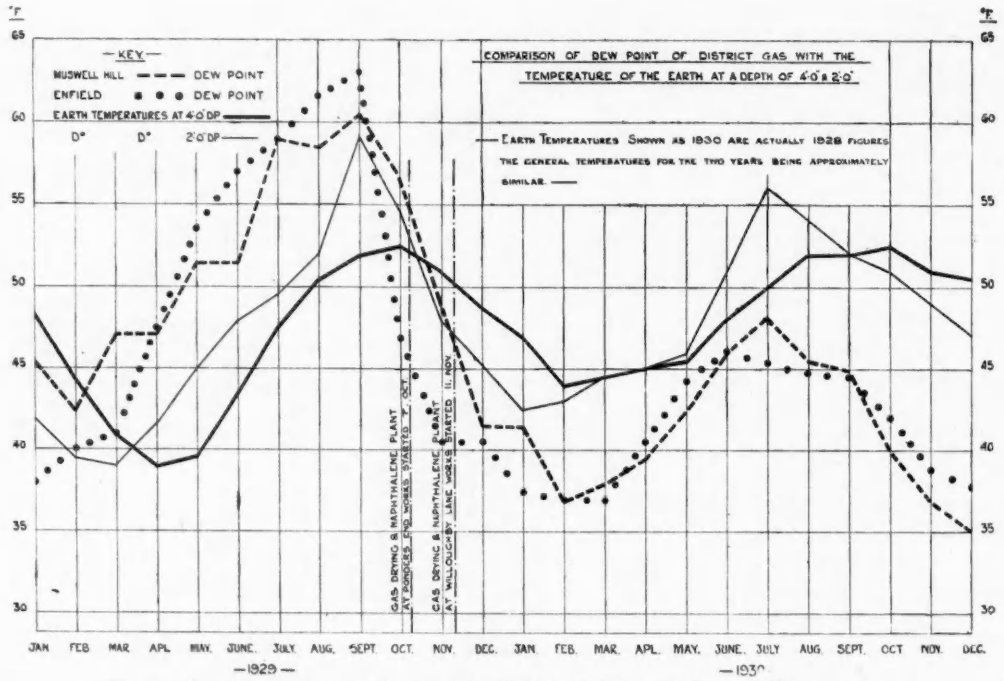

°F
65
60
55
50
45
40
35
30
—KEY—
MUSWELL HILL — — — DEW POINT
ENFIELD • • • DEW POINT
EARTH TEMPERATURES AT 4·0 DP ——
D° D° 2·0 DP ——
COMPARISON OF DEW POINT OF DISTRICT GAS WITH THE TEMPERATURE OF THE EARTH AT A DEPTH OF 4·0 & 2·0
—EARTH TEMPERATURES SHOWN AS 1930 ARE ACTUALLY 1928 FIGURES THE GENERAL TEMPERATURES FOR THE TWO YEARS BEING APPROXIMATELY SIMILAR.——
GAS DRYING & NAPHTHALENE PLANT AT BORDERS END WORKS STARTED 7th OCT.
GAS DRYING & NAPHTHALENE PLANT AT WILLOUGHBY LANE WORKS STARTED 11th NOV.
JAN FEB MAR APL MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APL MAY JUNE JULY AUG SEPT OCT NOV DEC.
—1929—
—1930—

FIGURE 2.—*Comparison of Dew Points of District Gas and Ground Temperatures.*

way back to the plant by means of a cold water flow over the pipes.

Benzole Recovery

After this plant had been at work for some little time a certain amount of trouble from gum was noticed on the district, particularly in district governors. This was at first put down to the removal of inhibitors by the gas oil in the naphthalene extracting plant, and an oil regeneration unit was installed and a circulatory oil flow of about 200 to 300 gal. per hr. established. A little crude benzole and crude naphtha was made by this plant and, although little improvement could be noted so far as gum was concerned, the possibilities of a more extensive benzole removal were well demonstrated. Accordingly a further and larger primary distillation unit was installed and the oil circulation was increased to about 1,400 gal. per hr. This resulted in the extraction of about 2 gal. of benzole and naphtha per ton of coal carbonized.

A new difficulty now arose in a serious shortage of cold water for cooling purposes. It was estimated that a further quantity of cooling water to the extent of 70,000 gal. per day would be required. This could not possibly be provided from the water resources at the Company's command without purchasing from the town's water supply. This purchased water would be hard water, and, owing to scaling, the oil could not be cooled below 80° F. during 6 months of the year. At this temperature the daily benzole yield would be reduced from the neighbourhood of 1,400 gal. to 850 gal. In addition to this loss of benzole, extra water costs would be incurred. The question of refrigeration was investigated, and an ammonia refrigeration unit by J. and E. Hall was installed. It is estimated that by the adoption of the refrigeration plant the savings have been between £4 and £5 per day, taking into consideration water saving and efficiency of extraction.

Operation of Plant

The operation of the gas drying and crude benzole plants is carried out by three men, one per shift, who maintain the chloride solution at the correct specific gravity and temperature, and take periodical hygrometer readings on the Dri-gas plant. The benzole stills and the oil cooling are regulated according to readings of distance thermometers placed at convenient points. The shift men are also responsible for the maintenance of chloride and oil circulations at rates specified by the Shift Superintendents.

There is, of course, a loss of volume in the gas after passing through these plants, of the order of about 1 per cent. by the extraction of water vapour and of 39 cu.ft. per gal. of benzole extracted. There is also a loss of thermal value to the extent of approximately 1½ therms per gal. of benzole. The calorific value drop is carefully watched by means of recording calorimeters at the inlet and outlet of the plant, and the Shift Superintendents instruct the plant operators in accordance with the readings of these instruments.

Humidity Tests

Another factor of great importance is that consumers receive the gas partially dried, whereas the official Gas Examiners' tests are made on gas re-saturated in the meter and corrected to saturated conditions at 60° F. To overcome this the Gas Referees, upon application, prescribed a test for humidity in conjunction with the calorific value test, which allows the Gas Examiners to correct the official value to the consumers' conditions.

The Gas Referees required proof of the degree of dryness of the gas on the district, and it was necessary, before making application for the amended prescription, to obtain data at various points on the district. The readings shown in Figure 2 represent some of this information.

Reports from Districts

Weekly reports are received from the Distribution Department, showing the number of complaints from each district or area of supply. These complaints are separated into three categories—water, rust, and naphthalene. The presence of water, in isolated cases, may point to a fracture in a main or in a service pipe. Many water complaints have, after investigation, been traced to the positioning of the meter. Meters have been placed in very exposed, and draughty, positions, with the result that the temperature of measurement was below the dew point of the gas and consequently water deposited. The majority of water complaints are from public lamp services.

If Figure 2 is examined it will be noticed that particu-

lar attention must be given to the gas-drying portion of the plant in the month of May, when the dew point of the gas approaches nearest to the ground temperature.

Coincidently with the installation of this plant a refinery was put into operation at the Leeside By-Product Works, and the crude benzole from Tottenham, together with that from other Works, was distilled to motor benzole.

Calorific Values

A central calorimeter house is situated at a convenient point where all the gases are brought together for drying and benzole washing. The instrument which has been standardized is the Fairweather recording calorimeter. Each manufacturing section—continuous vertical, intermittent vertical and water gas—has its own calorimeter. In addition, there is one calorimeter on the inlet to the benzole washing section and another on the outlet of this section, which may also be said to be on the inlet gas stream to holders.

Table 5.—*Thermal Balance Between all Gases Manufactured and Gases Sent Out*

	Thousand cu.ft. (Corrected)	Calorific Value.	Therms.
1	2	3	4
Therms by Addition:			
Intermittent vertical gas	39,324	531	208,845
Continuous vertical gas	35,997	521	187,481
Carburetted water gas	7,018	484	33,971
Total therms made (by addition)			430,297
Therms by Test:			
Total gas made—			
Corrected to N.T.P.	82,339	—	—
After correction for dew point (Average dew point 46·5° F.; factor 1·0068)	81,783	—	—
Correction for benzole volume at 39 cu.ft. per gal.	507	—	—
Corrected volume to holders	81,276	—	—
Calorific Value by Gas Examiners' test	—	504·9	—
Total therms by Gas Examiners' test	—	—	410,363
Benzole extracted (equivalent therms)	—	—	19,490
Total therms made (by test)	—	—	429,853

In this house there is also a gravitometer of the Alexander Wright type. Another apparatus worthy of mention is the Arkon oxygen recorder. This has been in use for five years and was the first instrument of this type to be brought to England. The connexions are so arranged that it can be put on any stream of gas and it is a very valuable means of controlling air admission for purification. This instrument has worked very satisfactorily and its accuracy is well within the limits of error of the ordinary Orsat apparatus. The gas leaving the Works is tested in the latest type Fairweather calorimeter, which is fixed in the Gas Referees' locked test room.

A thermal balance between all gases manufactured and gas sent out, as certified by the Gas Examiner, is made weekly as a check on the accuracy of the instruments. The method adopted is set out in Table 5, showing actual figures.

MAINTENANCE OF GASHOLDERS

For the past four years the gasholders have been examined in the manner suggested by the Gasholder Committee of The Institution of Gas Engineers, and this method is now being altered to comply with its latest recommendations. The method of painting is described in the Sub-section dealing with the General Maintenance of Works.

In order to examine the condition of the sheeting, samples are occasionally cut out with a trepanning machine. No trouble had been experienced with the water in the gasholders until 1932, when trouble with hydrogen-sulphide developed in the 180 ft. holder. At the end of 1931 repairs were effected to this holder which necessitated the emptying of the tank. The tank was refilled with new river water, i.e. water supplied by the Metropolitan Water Board. Since that date, with the seasonal changes of temperature when the water in the holder turns over, there is an evolution of sulphuretted hydrogen. With a view to minimizing this trouble as much as possible, the following procedure has been adopted:

At the end of October, just before the first serious frost is anticipated, the water in this gasholder is circulated over a set of disused atmospheric condensers. The rate of circulation is about 10,000 gal. per hr., and this is continued for three to four weeks. This aeration and exposure to sunlight has been found to be very effective in reducing the trouble. At the end of the three or four weeks there is a rest period, the duration of which varies according to the weather. Of late years a warmer period has prevailed between Christmas and January, when no circulation was necessary. At the end of January or beginning of February circulation is again commenced for about three weeks to allow for the water turning over in the next cold spell.

A further point which hitherto does not appear to have received much attention is the examination of the water in the lutes. Samples of water from lutes in the gasholders at Tottenham have shown that it is quite possible for the water in the upper lute to be acid whilst the lower lutes are almost invariably slightly alkaline. This condition has been found to be present both in town and country Gas Works, and from these findings it is obvious that the upper lift will have to be dropped into the tank more frequently than has hitherto been the practice.

CARBONIZING RECORDS AND COSTING DEPARTMENT

A Paper on Works Control cannot be complete unless it shows how, during the process of manufacture, checks are kept on working costs, and, with this object in view, a short summary is given of the methods adopted. A specimen of a sheet taken from the Yearly Report for 1937 is given, which shows the manner in which the costs are built up.

The primary Works statistics, which are designed to record the manufacturing position with accuracy and simplicity, may be classified under two headings:

1. Carbonizing results and data recording the operation of manufacturing plant and processes.
2. Costs, culminating in a monthly Net Cost of Gas into Holder, during the building up of which a net cost for each gas making section is determined and subsidiary figures produced.

All these figures are interrelated, and it has been realized that they must be produced in such a manner that their significance in relationship to one another shall not be lost, overlooked, or wrongly assessed.

To this end there exists a Costing and Carbonizing Records Department, which is organized on a flexible basis. In addition to a routine presentation of Works results, this department records and analyses data drawn from varied sources, and is therefore in a position, under the direction of the Works Engineer, to prepare estimates and forecast probabilities to help in the determination of future policy.

In the following notes the description of the system operating has been condensed as far as is compatible with clarity.

Carbonizing Results and Outputs

It is essential that a concise picture of the working results and outputs for each 24 hr. period (6 a.m. to 6 a.m.) shall be available to the Works Engineer as early as possible each morning. To this end a Daily Report is prepared and is on his desk by 9 a.m.

This report is compiled from various Plant Working Sheets and the Meter Book kept by the Valve man who is

ALL COSTS GIVEN IN PENCE PER THERM MADE
Therms: 10,988,036

	£	s.	d.	Per Therm.	£	s.	d.	Per Therm.	1936.
Gross cost of coal (per ton) ..								3·66	
Less Residuals:									
Coke									
Breeze									
S/ammonia ..									
Tar									
Crude benzole									
								2·96	
Net cost of coal (per ton)								0·70	
Add:									
Carbonizing wages								0·15	
Coke handling wages								0·08	
Purification wages								0·03	
New oxide								—	
Section repairs								0·12	
Proportion of general repairs								0·26	
Sundry manufacture charges								0·53	
Net Cost of Gas into Holders								1·87	

SHEET 1.—*Intermittent Vertical Retort House.*

responsible for the meters. It shows at a glance the previous day's carbonizing results, outputs and output fluctuations, compared with the corresponding day for the previous year; also calorific values, gas made, and the position of gas, coal, and oil stocks. With this report there appears, incidentally, the Shift Superintendent's diary, which is a brief summary of the previous day's working conditions.

Carbonizing Book

The pivot of the Carbonizing Records system is a comprehensive Carbonizing Book, which contains all the principal figures. From this book and its predecessors it is possible to extract any figure of primary importance in connexion with gas manufacture for many years past. An important point making for speedy reference is the fact that the figures are available in daily, weekly, fortnightly, monthly, quarterly, half-yearly, and yearly totals.

This book and the various Plant Record Books are all compiled from the detailed Plant Working Sheets mentioned above, which are received daily from each manufacturing section and other important points on the Works. The responsibility for the accuracy of the information contained on these sheets rests on the chemist or foreman in charge of the plant. The figures are also subjected to a series of checks in the office.

At the close of each week (6 a.m. on Thursday) a Carbonizing Return for the seven days is prepared; this summarizes and amplifies the information given in the Daily Reports. In addition, a further weekly statement gives details of the gas making plant at work, available for work and under repair.

Manufacturing Statement

A detailed analysis and grouping of all available data is carried out at the conclusion of each calendar month. The quantity of each residual product made for sale is calculated and a Manufacturing Statement is issued which gives:

(*a*) Position of coal and oil stocks;
(*b*) Residual stocks and makes;
(*c*) Fuel used for gas making purposes (including boiler fuel);
(*d*) Total corrected gas makes and coal carbonized, with the usual residuary information;
(*e*) Outputs and official tests.

All these figures are so displayed that reference is easy and automatic.

COSTING SYSTEM

The ultimate object of the Costing System, as well as a natural corollary of the technical figures, is to produce a monthly Net Cost of Gas into Holder for each manufacturing section and for mixed gas.

Periodical Results

This object is achieved, and the results issued monthly, together with most subsidiary figures and the carbonizing results, in the Works Progressive Report, a loose leaf volume which is supplemented by a series of columnar graphs, 20 in number. The graphs are washed in colour on a prepared form, foolscap size, and the capacity of each form is six years. Two sets are prepared, one being framed in the Works Engineer's office and the other enclosed in a folder for the Chief Engineer. (A specimen of these graphs is given in Figure 3.)

The Works Progressive Report is followed by a six-monthly Summary of Costs and finally by the Annual Works Report, which is a volume of some 60 pages containing all the costs and carbonizing results for the year. The latter has proved to be of immense value as a work of reference in the office and is a succinct chronicle of the actual manufacturing position for the year.

Basis and Operation of Costing System

The information necessary for the establishment and operation of the Costing System falls under three major headings:

1. Cost of materials.
2. Cost of labour.
3. Value of residual products.

The basic principles of the system are:

(i) A series of Cost Numbers which are allocated to important items of plant, machinery, etc., and processes.
(ii) A Key by means of which the sums of money listed under the foregoing Cost Numbers are debited to the gas making section they concern.
(iii) The technical figures available from the carbonizing records, including the quantities of residuals made for sale.
(iv) The provision by the Accounts Department of information regarding the total quantities of residuals sold and the value thereof.

A complete list of Cost Numbers in booklet form is issued to all officials and foremen empowered to issue requisitions for material on the Works Stores, or who are responsible for the allocation of the labour under their control. Any addition to, or revision of, the Cost Number book is instantly circulated and a signature to the effect that it is understood and noted is obtained from each person affected. No alteration is made to the Cost Number book unless it has been authorized by the Works Engineer.

A Cost Account for both wages and material is opened for each Cost Number heading and all Cost Accounts are closed at the end of each calendar month.

Cost of Materials

The only materials not dealt with by the Cost Number method are the raw materials of manufacture—coal, gas

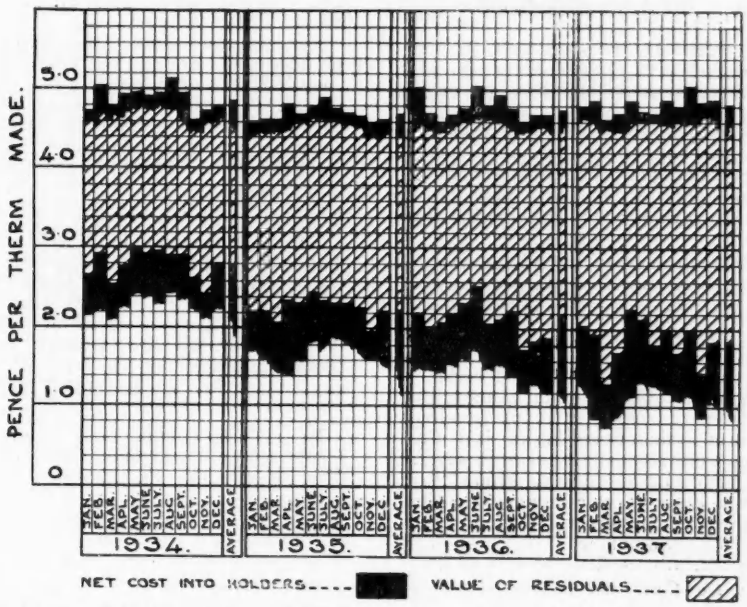


FIGURE 3.—*Net Cost of Gas into Holders: Intermittent Vertical Retort House.*

oil, coke and breeze, and oxide. As these are not handled through the Stores, they are debited, as used, direct to the final Cost into Holder Sheet of the Sections concerned.

Coal.—Throughout each month a record is kept of the tonnage of all types of coal elevated to each retort house. These quantities are priced at contract prices and the totals thus arrived at are designated the "Gross Cost of Coal." Stock coal carbonized during the month is debited at the value shown in the most recent Balance Sheet.

Gas Oil.—The cost of gas oil is debited to the water gas plant and benzole extraction plant as used, at contract price plus duty.

Coke and Breeze.—Retort house fuel is ignored when coke makes are assessed and need not therefore be considered. The cost of coke and breeze used on the water gas plant and boilers is debited at the lowest contract price received for sales. (Incidentally, this coke cost is later credited to the residual values of its house of origin at the same figure.)

Oxide.—The cost of oxide is debited to each section as used, at the purchase price less any credits due for spent oxide sold or otherwise disposed of.

Stocks of Raw and Other Materials

Book stocks of all raw materials and residuals are kept, and every six months these are compared with measured stocks. All material other than that mentioned above is delivered to the Stores and its receipt recorded by the Storekeeper in the Goods Received Book, a leaf from which is sent each day to the Costing Office.

Invoices for such material are listed, as received, in an Accounts Register and compared with the appropriate entry in the Goods Received Book and also with a copy of the original order, before payment is authorized.

It may be mentioned here that a similar system, slightly modified, ensures that goods supplied and work carried out by the Distribution Stores and Shops for the Works are also included in the Costs.

Stock Recording

All material taken into store is recorded on Stock Cards in the office. These cards are posted as follows:

Goods Received columns—from Goods Received book.

Cost and Price columns—from invoices.

Goods Issued columns—from requisitions which have passed through the Stores.

No goods whatever may be withdrawn from store unless a duly authorized requisition is presented.

Credit notes are also provided so that surplus material returned to store may be credited to Stock Cards. Actual stocks of all material in store are checked with the stock cards at each half-yearly period.

Bringing Material to Charge

All requisitions and credit notes received by the Stores are forwarded daily to the Costing Office, where they are dealt with as follows:

1. Marked off on Identification Slips, to ensure that none is lost.
2. Posted to Stock Cards.
3. Scrutinized to ensure that each bears a description of the job for which material was required and also the correct Cost Number.
4. Posted daily to appropriate Cost Account.
5. Neatly filed in date order.

Duplicate copies of all invoices for material and services rendered are sent to the Costing Office and clearly marked "Stock" or "Direct Charge".

The material specified on those marked "Stock" is dealt with through the Stores requisition and Stock Card system as described above, and these invoices are merely used to keep the pricing book up to date.

Those marked "Direct Charge" are allocated by the Works Engineer to the job for which the material was purchased, the Cost Number is added by the Costing Department and the amount immediately posted from the invoice to the Cost Account.

All duplicate invoices are then checked against the Accounts Register to ensure that none is missed. The Cost Accounts are priced and totalled weekly and the amounts finally transferred at the close of each month to a Materials Cost Summary. This book, therefore, contains the total monthly charge against each Cost Account listed under Cost Number headings. It makes provision for accumulating totals up to six months.

Cost of Labour

Labour costs are compiled by a Dissecting Time Clerk in conjunction with the Time and Wages Clerks. The system here is based upon a series of Dissecting Time Books, one of which is issued for every foreman. The Dissecting Clerk enters each man's name and rate weekly in the appropriate book and calculates the total wages due to him. This calculation is entirely independent of the official Wages book, with which the final result must agree. He then proceeds to collect the information by means of which the total wages of each man are dissected under

Cost Number headings. There are several methods of doing this:

1. In the case of shift workers in retort houses, the foreman enters a description of each man's work, with the time spent thereon, and the Clerk enters the Cost Number.
2. The Chemist in charge of the Chemical Works supplies daily a time sheet detailing each man's day.
3. The Dissecting Clerk himself visits all fitters at frequent intervals and obtains from each man details of the jobs upon which he is engaged, with the time spent thereon.

When all the necessary information is to hand the remaining columns of the Dissecting Time books are completed, totalled, and agreed with the actual wages columns.

Bringing Labour Costs to Charge

Upon completion of this work there exists a series of books in which the total time of every man is accounted for, the complete dissection consisting of many hundreds of small amounts, each of which bears beside it a Cost Number. Many of these Cost Numbers appear in several of the books, and the next operation is to group them and carry the results to a Wages Cost Summary identical in form with the Materials Cost Summary. The total sum appearing in the Wages Cost Summary must agree with the Wages Book, and is officially certified to this effect.

Ascertainment of Cost into Holder

By means of the Key previously mentioned the amounts in both Wages and Materials Summaries are re-grouped ready for posting to the Cost into Holder Sheets.

Key to Costs

Briefly, the Key functions by grouping:

1. All the Cost Numbers which are chargeable directly to each gas making section and sub-dividing them into manufacturing costs, repairs costs, and manufacture sundries.
2. All the Cost Numbers which are chargeable to coal gas sections and sub-dividing them into repairs and sundries.
3. All the Cost Numbers which are chargeable to all sections and sub-dividing them into repairs and sundries.

The last two groups are debited in proportion to the gas made at each section.

There are many other Cost Numbers which are not connected with gas manufacture, as an account is kept of all work carried out for other departments of the Company. Transport, also, is dealt with entirely separately and charged to the departments which use it. The Key makes provision for the grouping of these Costs in such a manner that details of them may be communicated regularly to the departments concerned.

Cost into Holder Sheets

The results of this analysis, in so far as they concern the Works, are posted to the Cost into Holder Sheets—one for each gas making section and one for mixed gas, and the Gross Cost of mixed gas is built up as follows:

Carbonizing and water gas manufacture wages.
Coke handling wages.
Coal, coke and oil.
Purification wages.
Oxide.
Section repairs.
General repairs.
Sundry manufacture charges.
Gross cost.

Value of Residual Products

The next step is to deduct the value of residuals from the Gross Cost, and this is calculated in the following manner:

To the total quantity of each residual sold and the amount of money received is added the quantity used on the Works and its value respectively. The cost of transport is then deducted and an average value per ton or per gal. is obtained. These average values are used to price the total quantity of each residual made for sale, and the result of this calculation is credited to the Cost into Holder Sheet.

Very careful records are kept by the Sales office, where all documents are marked with the type of coke sold, thus ensuring that each retort house is credited with its true values. A considerable amount of detail work is necessary to achieve this object, but the results have brought to light some important fundamental facts regarding the coke market and the effect of coke values upon various Costs into Holder.

Cost into Holder

The Cost into Holder Sheets give the cost per therm made at each section progressively for one year and the mixed gas sheet gives the cost per therm made and also the cost per therm on the declared calorific value basis. At quarterly and half-yearly periods the various Costs into Holder are examined in relation to the corresponding figures for the previous year, and the cause of any fluctuation is determined and explained.

Other Figures

In addition to the main figures outlined above statements are produced monthly showing, in detail, the effect of residual values on the Gross Coal Cost.

Each car and lorry owned by the Company is allocated a Cost Number and detailed costs are kept. The total cost of each vehicle is calculated monthly and a statement is prepared which shows the cost of transport to each department.

Lubricating oil costs are analysed each month.

Detailed repair costs of any important machinery are available for extraction from the Wages and Materials Summaries, *e.g.*, a statement of the cost of coke screening plants is prepared, calculated on the coke made for sale at each section.

Abnormal Work

Upon the commencement of any new work or work of an exceptional nature such as re-setting retort benches, a special Cost Number is issued. This ensures that the Cost into Holder is comparable at all times, as these numbers are not included in the monthly costs. Upon completion of the work the Number is closed and thus the prime cost of any installation is available. A statement of the amounts allocated to special Numbers is included in the Annual Works Report.

Residuals Costs

An investigation into the question of coke revenue is attempted annually. All Works Costs in connexion with the preparation and distribution of coke are assessed and offset against the total revenue accruing. Coke sold for the domestic market is dealt with as far as possible independently of the industrial market, and a revenue figure per ton for each is obtained.

Profit and Loss Accounts, with detailed statements of expenses, are prepared each half-year for benzole, sulphate of ammonia, and other products. Several of these are utilized by the Secretary's Department, and all are included in the Annual Report.

Other Manufacturing Stations

The Carbonizing and Costing system, substantially as described above, is operated at all other Gas Manufacturing Stations of the Company and the correlation and grouping of the figures is dealt with by the central organization at Tottenham. A combined Cost into Holder, calculated on the total declared therms of each Works is included in the monthly Progressive Report, which also has sections for the detailed costs of each Works.

General

With regard to office organization, it has been found that the provision of portable calculating machines has greatly increased the output of the Costing Department: without them the scope of the system would have to be greatly curtailed. For the speedy collection of a great deal of necessary information from other departments a considerable quantity of stationery is required and the use of a foolscap size duplicating machine enables forms to be devised and printed at a moment's notice. This machine is also used to produce all the reports issued by the Costing Department.

News of the Week

For Public Lighting, the Willenhall Urban District Council have accepted the tender of the Willenhall Gas Company.

A Display of bombs and parts of aeroplanes was staged last week in the showrooms of the Nottingham Gas Department by the Royal Air Force.

Coal Imported for Gas Manufacture in Eire during the first three months of the year amounted to the value of £88,951 as compared with £75,173 for the corresponding months last year.

To Ascertain from the Inhabitants of the adjoining villages of Stoke Golding and Wykin whether there would be a sufficient demand for gas if a main was laid to the villages is the object of a survey which is being prepared by the Hinckley Gas Company.

This Year Marks the Centenary of the introduction of gas at Kilkenny. In a local newspaper of Saturday, Nov. 23, 1838, the following appears: "We are happy to announce the gratifying fact that Kilkenny has at length advanced one step in the march of improvement. Our streets and most of our shops were lighted with gas for the first time on Wednesday evening last."

A Series of Demonstrations of home service and practical cookery, arranged by Mr. E. Longbottom, Sales Manager, were recently given in the Knifesmith Gate showrooms of the Chesterfield Gas Department. The first session was opened by Mrs. Rodgers, wife of Councillor S. T. Rodgers. Councillor W. P. Warner presided in the unavoidable absence of Alderman G. Clark, Chairman of the Gas Committee, and Alderman A. W. Swale, Vice-Chairman. There was a large attendance.

An Address to the Perth Rotary Club was delivered on May 19 by Mr. A. C. Rea, Engineer and Manager of Perth Corporation Gas Department.

The Gas Manufactured for the twelve months ended March 31 by the Lincoln Gas Department shows an increase of 66,176,000 cu.ft., approximately 8½%, making a total output of 791,136,000 cu.ft., an increase of 50% in the past six years.

Following a Recommendation by their Gas Engineer, the Darlington Gas and Electricity Committee have reduced charges in the rural district. From the quarter commencing April 1 last charges for gas supplied in the outer districts will be reduced by amounts varying from 1·4d. per therm for the first ten therms to 0·21d. per therm for all over 5,000 therms.

The Best Method of Cooking a Skunk was recently demonstrated by Will Mahoney, the well-known comedian, in the Gas Pavilion at the Empire Exhibition, Glasgow, in aid of the Markham Colliery Disaster Fund. This visit was arranged by the staff of the Pavilion, to whose good work for the fund we referred in last week's issue. Mr. Mahoney, who was introduced by Councillor Wilson, Convenor of the Glasgow Gas Committee, afterwards signed numerous autograph books. Mrs. Mahoney and he thereafter disposed of a large number of lottery tickets, the prize being a cake baked by Miss D. M. Gillham, B.P.T.C., of Messrs. R. & A. Main, Ltd., who is giving a series of demonstrations. A large audience was present and a substantial sum was realized for the Fund.

"Dowtherm" Heat Transfer System

A license for the development in this country and the Empire, except Canada, of "Dowtherm," the high-temperature heating medium, which is now being used on an extensive scale in the United States, has been arranged by Messrs. W. J. Fraser & Co., Ltd., Dagenham, Essex, with the Dow Chemical Company, U.S.A.

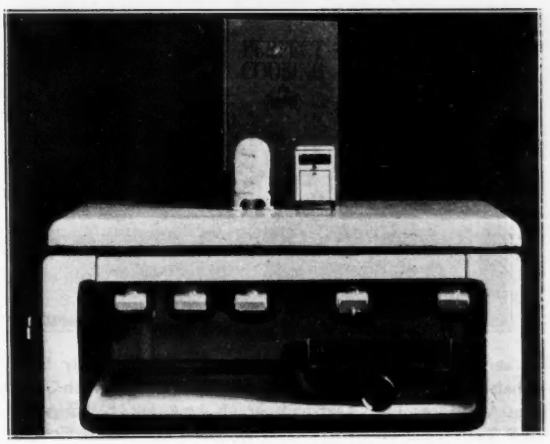
"Dowtherm" is the eutectic mixture of diphenyl and diphenyl oxide, and it is applied in heat transfer systems usually in the vapour phase. It is claimed to represent a real advance in heat transfer *media*, and has its chief applications over the difficult range of 210° C. to 400° C. Among the advantages stated by Messrs. Fraser to be gained by the use of "Dowthern" for this temperature range are the following. As heating is performed by the high latent heat of condensation being given up on the transmitting surfaces, the rate of heat transfer is stated to be higher than in methods where all of the heat is supplied only as sensible heat. Surfaces are not fouled by the deposition of sludge formed by decomposition of the heating medium. Even at the maximum temperature, the pressure is not high. Since "Dowtherm" is used as a saturated vapour, heating in done at a uniform temperature, not by a fall in temperature, as in circulating fluid systems. Local overheating is impossible. Temperature control is simple and precise. "Downtherm" is non-corrosive and gives high fuel to vapour efficiency figures.

The licensees also state that the vapour heating plant is straightforward in operation and not expensive to install, though the design and manufacture of the equipment naturally call for special experience with the medium. The system can be applied to a great variety of processes, including fatty acid distillation, plastics, caustic soda evaporation from the soda ash process, and autoclave saponification at high temperatures.

Meters, Ltd., Manchester

The Directors of Meters, Ltd., Manchester, in submitting the accounts of the Company for the year ended March 31, 1938, state the net profit amounts to £23,489, which added to the balance of £10,598 brought forward, gives a total of £34,087. After deducting the interim dividends amounting to £6,454 paid in November last, the amount available for appropriation is £27,633. The Directors recommend the following: The creation of a Reserve for National Defence Contribution of £1,900; the payment of final dividends for the year ended March 31, 1938, of 2¼% (actual) upon the preference stock, and of 6½% (actual) upon the ordinary stock, making the total dividends for the year 5½% upon the preference stock and 9% upon the ordinary stock (both less income-tax); and that the balance of £13,696 be carried forward to next year's Accounts.

"Renown" Cooker for Model House



Tacit acknowledgment of the leadership of the Gas Industry in the design of up-to-date gas cooking appliances was recently revealed by the Rushden and Higham Ferrers Gas Company. Mr. B. Whitby, who is associated with a local garage, was engaged in his spare time in building a small model of a modern house. In the course of making suitable equipment for the kitchen, he paid several visits to the Gas Showrooms to examine in detail the Parkinson "Renown" Cooker, which he had chosen to harmonize with the up-to-date interior. The finished model, an attractive replica in metal of the "Renown," is illustrated in the accompanying photograph on the cover of an actual cooker.

Gas Water Heaters for Mill Hill Estate

Negotiations have recently been concluded between the North Middlesex Gas Company and Messrs. George Wimpey & Co., Ltd., for the standardization of an NEA 32 "Ascot" gas water heater in each of the 397 houses which the latter are building in Mill Hill, N.W. 7.

Possibly the most interesting feature of this news is that these large contractors have never before, we understand, standardized gas water heaters in the houses on any of their numerous estates.

Formation of Engineering Precautions (Air Raid) Committee

The Institution of Civil Engineers, with the approval and collaboration of the Air Raid Precautions Department, have appointed a Committee for the compilation and publication of authoritative technical information on the subject of precautions against air attack for the use of engineers in their work and design, construction and maintenance of structures and other engineering work, including public utility services.

This Committee which, under the Chairmanship of the President of the Institution, consists of engineers conversant with both the practical and scientific aspects of the subject, has been promised by the Air Raid Precautions Department all possible assistance in the form of available scientific data concerning the problem. It is hoped that this will be the means of conveying to engineers throughout the country valuable help in dealing with the problems which confront them now and in the future as the result of the development of aerial warfare.

Cake Baking at Cheltenham

A series of cookery demonstrations was held recently by the Cheltenham and District Gas Company in conjunction with General Gas Appliances, Ltd. Our photograph shows Miss N. Longworth, C.D.S., M.C.A., with the entries for the Cake Baking Competition, of which there were over a hundred.

Cooking in the City of Chichester

Feminine interest was recently aroused by a display of the latest "New World" cookers, the "45" and "48" and the Cabinet Cooker No. "365" at an exhibition, which included cookery demonstrations, held in Chichester from May 10 to 13 inclusive. A record number of people attended the cookery demonstrations, approximately 120 each day, and on the last day the hall was filled to overflowing, people having to stand at the doors.

The exhibition was opened by Mr. Rutter, a Director of the Chichester Gas Company, supported by co-Directors. Cake-baking competitions, both for adults and children, attracted a number of entries and three prizes were awarded with three consolation prizes in each case. The demonstrations, carried out jointly by Miss G. Hocken, of the Radiation Research Kitchens, and Miss D. H. McFarlane, of Cadbury Bros., Ltd., proved a great success. Miss Hocken gave a comprehensive syllabus of interesting dishes throughout the week and Miss McFarlane concentrated on chocolate cookery only.

Displays of "New World" cookers by Radiation Ltd. and of gas water heaters by Ascot Gas Water Heaters, Ltd., added considerably to the attractions of the exhibition.

Oil from Coal

The Gas Industry's Part.

Commenting in Edinburgh on May 19 on the Government's decision to accept the recommendations of the Falmouth Committee, Councillor Walter Muter, ex-Convener of Edinburgh Corporation Gas Committee and Past-President of the B.C.G.A., said that the decision, while a notable advance of Government policy, still left unsettled the question of the recovery of oil from coal as practised in the gas-works of this country.

"It seems to me that, in view of the notable contribution made by the Gas Industry in the extraction of oil, the Government should make a pronouncement of policy. The recent valuable experiments carried on at Granton Gas-Works, Edinburgh, by Mr. Jamieson, the City Gas Engineer and Manager, and Dr. King, of the Fuel Research Station, in respect of the extraction of oil from cannel coal, have proved beyond any shadow of doubt the valuable field of recovery that is open for exploitation.

"It now remains for the Government to order a geological survey so that the quantity of cannel coal can be roughly determined. At the moment that valuable deposit lies in extensive seams unmined, and I cannot think that such a state of affairs would be permitted in a country like Germany, where extensive mining and chemical experiments have proved of great advantage in recent years. The Gas Industry is prepared to play a full part in the recovery of oil from coal and help towards the conservation of our oil supplies in times of emergency."

Successful Ashton Exhibition

Alderman Joseph Toole, J.P., ex-Lord Mayor of Manchester, opened the Ashton Gas Company's "Home Service and Health Exhibition" at the Demonstration Theatre, Gas Offices, Oldham Road, on May 2. During the subsequent fortnight 1,530 persons attended.

The Chairman, Alderman Sir Charles Booth, J.P., expressing the pleasure it gave him to be present, said he very willingly accepted the invitation to preside because of his long association with the old Company. He assured Alderman Toole of a hearty welcome.

Alderman Toole spoke of his delight at having the opportunity of opening the exhibition.

Mr. William Bennett, General Manager, Ashton Gas Company, cordially thanked Alderman Toole, who, in responding, remarked upon the astonishing way in which the manufacture of gas appliances, faced with competition, had set about the task of effecting improvements in their goods.

A vote of thanks was extended to Sir Charles by Mr. G. Douglas Gill, Sales Manager, who also thanked the audience and hoped they would enjoy the demonstrations and talks. The exhibition comprised a wide range of gas appliances, the co-operating manufacturers being Ascot Gas Water Heaters, Ltd., W. H. Dean & Co., Ltd., and Richmonds Gas Stove Company, Ltd. (Radiation Ltd.). Laundry demonstrations were given twice daily by Miss S. A. Singleton.

Particularly attractive features of the exhibition were the cookery demonstrations, also conducted twice daily by Mrs. E. Hardy, of the Radiation Research Kitchen. Using a "New World" gas cooker, with the "Regulo" automatic oven-heat control, Mrs. Hardy has greatly interested a large number of housewives during the week with her lucid explanations regarding the finer side of cookery. Health talks by Mr. T. Bowen Partington, F.I.L., F.R.E.S., have been appreciated.

Insidious Electrical Propaganda

In the Northern Ireland House of Commons on Thursday last Mr. E. Warnock, K.C. (U., St. Anne's, Belfast), asked the Minister of Commerce if he had seen a copy of a circular which was posted to householders in Northern Ireland purporting to be a synopsis of a book entitled "The Cause of Cancer," in which it was stated that the average gas cooker was a primary cause of cancer; whether that document had been circulated by the Electricity Board for Northern Ireland, and whether the areas chosen for its circulation were those in which there were prosperous gas undertakings; whether he had seen the statements emanating from the Imperial Cancer Research Department which described the book as a "tissue of errors and not worth reading;" and the theories propounded as nonsense; and whether he would take immediate steps to see that that form of propaganda by the Electricity Board ceased forthwith.

The Minister of Commerce said he had seen the circular and the comments thereon emanating from the department of the Imperial Cancer Research Fund. He understood that the distribution of the circular by the Electricity Board for Northern Ireland had been confined to the Borough of Bangor. He had expressed to the Chairman of the Electricity Board his strong deprecation of that form of propaganda, and had received from him an assurance that no more would be permitted.

British Standard Specifications for Tarmacadam

The British Standards Institution has just published Standard Specifications for Tarmacadam: Part 1—Tarmacadam (Granite, Limestone, and Slag Aggregate), Part 2—Surfacing of Roads with Tarmacadam. B.S.S. No. 802-1938.

These Specifications have been prepared on a broad basis, and provide for the laying of tarmacadam surfacings by the ordinary, semi-hot, and hot processes. Hot process tarmacadam was formerly known as tar concrete, and in addition to the experience gained in this country by its use it has also been used with great success on the Continent. Special attention has been given to the grading of aggregates and the use of fillers, and figures are given for the mixing temperatures of the aggregate and binder for the respective processes. The recommended tars are B.S.S. No. 76-1930 (Tars Nos. 1 and 2), and B.S.S. No. 76—Part 2—1931 (Tar No. 3) for road purposes, and the minimum quantity of binder per ton of mixed aggregate and filler for each process is given. Provision is also made in the Specifications for the use of mixed binders.

Copies of these British Standard Specifications No. 802-193 can be obtained from the Publications Department, British Standards Institution, 28, Victoria Street, London, S.W. 1, price 2s. each, 2s. 2d. post free.

The Drying of Washed Clothes

The most recent addition to the technical bulletins which are published from time to time by the Kitchen Planning Centre (sponsored by Lever Brothers, Ltd.), which is a non-commercial research association, deals with "The Drying of Washed Clothes." In it the results of an interesting piece of research into the drying of an average weekly wash are given, and it is pointed out that there is a necessity for adequate drying facilities independent of weather conditions for all domestic drying. It is estimated that for the drying of the average family wash the distances walked when outside drying facilities are used may be ten times those required if an efficient indoor drying cabinet is installed.

It is stated that the conditions necessary to ensure adequate drying in a domestic cabinet are a rate of air flow of 70-80 cu.ft. a minute and an increase in the water vapour content of the air of 10-11 grains per cu.ft., and that the majority of present-day driers fail to attain the high standard of efficiency required for adequate performance. It is suggested that considerable heat losses occur with most cabinets and that attention to constructional details is needed in this regard. Useful hints are given on the arrangement of the clothes in the cabinet, and the characteristics of a selection of drying cabinets at present on the British market are set out. The economic aspect of the subject is not, however, considered.

Safe Driving Competition

Success of National Benzole Drivers.

It is announced that 84% of the drivers employed by the National Benzole Company, Ltd., who entered for the Safe Driving Competition in 1937 were successful, as compared with 81% in 1936. One of the drivers, with 15 consecutive years free from blameworthy accident, received a Special Bar to his Gold Medal, and another, with a similar record for 13 years, received his third Oak Leaf Bar to the Gold Medal. Drivers with ten consecutive years' freedom from accident receive the Gold Medal, which, in the case of London men, will be presented by the Lady Mayoress at the Guildhall, London, on May 31.

For fifteen years now, the National Benzole Company, who are one of the largest motor transport operators in the country, have entered their drivers for this country-wide safe driving competition, and their policy of impressing on them the need for adhering to safety first rules and practising the "courtesy of the road" has borne fruit in a surprisingly low number of accidents among their vehicles. The success of their efforts is shown not only by the large percentage of their drivers who achieve distinction in the safe driving competition, but by the many letters the Company receives from motorists and others expressing appreciation of courteous actions on the part of their drivers.

The Fire that Only *Looked* Warm

The Queen's Experience in Manchester

In the course of their recent visit to Manchester the King and Queen carried out their tour in very inclement weather. At one point Her Majesty remarked to the Lord Mayor who was accompanying her that she felt cold.

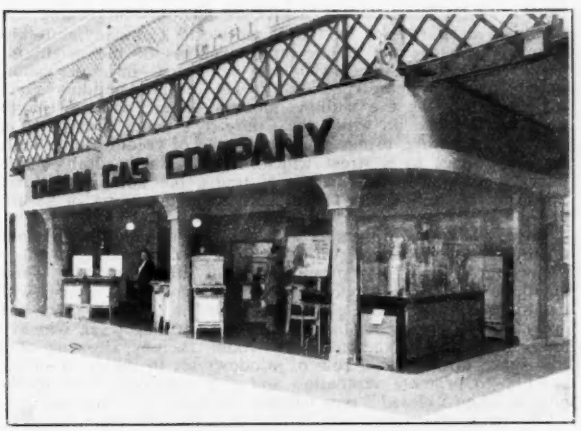
On entering the new Manchester Town Hall they passed through the electricity showrooms, and, seeing an illuminated electric fire, the Queen left the procession to warm her hands. But it was an ornamental fitting which did not throw out any heat, and she rejoined the King whom she smilingly told that she did not feel much warmer.

A moment or two later after passing through the Great Hall the Royal Party entered the gas showroom where the Queen tried a gas fire from which real warmth was coming.

"It's very nice and warm in here," she told the Mayoress as she stood before the gas fire.

While in the showroom the Queen paused to admire a coloured lampshade.

Gas at the Royal Dublin Show



The stand of the Alliance and Dublin Consumers' Gas Company at the Royal Dublin Spring Show held during the first week in May. This attracted a great deal of attention with such interesting exhibits as self-lighting cookers, a lightning sketch artist, and a model gas-works producing gas throughout the duration of the show.

Shredded Wheat to be Baked by Gas

Makers of the well-known cereal, the Shredded Wheat Company, Ltd., Welwyn Garden City, are extending their premises by the addition of a large single-floor building covering an area of 70,000 sq.ft., which when completed will be one of the features of the rapidly developing Garden City.

In order to maintain the wholesomeness and purity of their product, as well as of the surrounding atmosphere, as apart from control of temperature, &c., very careful consideration has been given to the question of the type of fuel to be used, and the Watford and St. Albans Gas Company announce that gas has been chosen in preference to other fuels for the heating of their specially designed large conveyor ovens. There will be four ovens, each having a baking chamber 70 ft. long, and each will use 5,400 cu.ft. per hr., making a total maximum consumption of 21,600 cu.ft. This figure, incidentally, will not only be the largest individual output in Welwyn Garden City, but also the largest in the 104 years' history of the Watford and St. Albans Gas Company.

In an article on the Hire-Purchase Bill (p. 364 of May 11), we inadvertently stated that "the hirer can authorize an agent to sign for him." This should, of course, have read "*cannot* authorize." **We apologise for the slip.**

New Showrooms for the Wandsworth Company at Tooting

Fine new showrooms—the 23rd in their area of supply—were opened for the Wandsworth and District Gas Company in Upper Tooting Road, S.W. 17, on May 16 in the presence of a distinguished gathering of local representatives, presided over by Mr. Frank H. Jones (Chairman of the Company).

The new premises, which replace an older showroom on the same site, are undoubtedly the most up-to-date in design and lay-out in the Company's area and are not only in keeping with the high standards set by the Wandsworth Company, but also definitely enhance the architectural amenities of the neighbourhood. Set in the midst of what may be termed—in no derogatory sense—a row of stereotyped shop-fronts, the new building immediately strikes the eye with its modern design, while its bright green stone facia, on which the Company's name is executed in red block lettering, brings a cheerful note of colour and refreshing clean lines to a street which, if not exactly drab, suffers under the handicap not merely of trams, but additionally of a profusion of architectural styles embracing the worst of several periods.

Three gas lamps in keeping with the style of the building stand on the pavement outside, with reflectors so arranged as to throw the whole exterior into prominent relief after nightfall. There are three showroom windows of unusual polygonal shape, with two stainless steel doors giving access to the interior. The windows are self-contained, having their own ceiling level, which is lower than that of the main showroom, thereby allowing of a free space through to a row of windows set in the front of the building to promote ventilation and give additional light to the interior when "closed" type window displays are being used.

The main showroom, which has an attractive inlaid polished wood floor and effective lighting fittings, presents a pleasing impression, with all types of domestic gas appliances neatly set out in groups. It is clear that the architect was presented with a considerable problem in obtaining satisfactory natural lighting of the main showroom—bearing in mind the fact that the buildings on either side were attached. The difficulty was largely overcome, however, by the judicious introduction of alcoves set back clear of the main building and provided with laylights, together with "clerestory" windows above. The carrying of the showroom right to the back of the building and introducing large windows above the staircase also assisted in solving the problem.

In the centre of the showroom is a compartment constructed of attractive polished woods and frosted glass, divided into two sections. The section facing the main doors is for the cashier, and has a counter across the front. The rear portion takes the form of a comfortable little "consulting" room, with table and chairs, where private interviews can take place. The outer sides of this compartment are tiered to provide an effective setting for the display of gas fires. Other gas fires are displayed in beautiful surrounds, while a special alcove is set aside for the water heating display. The different styles of woodwork and panelling employed throughout the whole building is particularly noteworthy.

In the basement is to be found a further display of appliances of various kinds, together with spacious stores approached by a ramp from the back.

A curving staircase at the rear of the ground-floor showroom leads to the upper floors past a series of windows on which pictorial representations of "gas" subjects have been sandblasted—a very effective and unusual feature in a showroom. This staircase brings one to the spacious first-floor demonstration room, which will comfortably accommodate some two hundred persons and is equipped with a demonstration platform which is a model kitchen in itself. Here, again, brightness is the keynote, the natural lighting from the front windows being assisted by a large laylight, fitted with ventilation grills, set in the ceiling; here again the gas lighting fittings are particularly attractive. An anteroom is provided for the demonstrators.

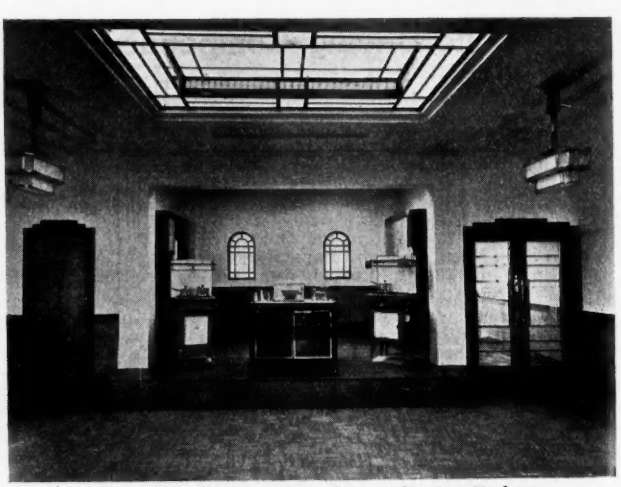
The building also includes commodious office accommodation, while space is available behind for fitters' quarters. Altogether the new premises at Tooting are a credit to a progressive Company and will not only enhance their prestige in the neighbourhood, but also provide increased facilities for serving the many consumers in this important section of their area of supply.

THE OPENING CEREMONY.

The opening ceremony was performed by Mrs. George F. Doland, who was accompanied by Alderman Lieut.-Col. G. F. Doland, O.B.E., J.P., M.P., in introducing whom Mr. FRANK H. JONES (Chairman of the Wandsworth Company) said they were very honoured to have so many prominent people from that neighbourhood with them. The Company had many showrooms, but this was certainly their very latest and, they considered, their best. It was their hope that the premises would enhance the attractions of that part of Tooting, as well as being an asset to the Company.

Alderman Lieut.-Col. G. F. DOLAND said he felt greatly

Ground Floor Showroom with Counter in Centre.



View of the Demonstration Room, showing Platform.

honoured to be connected, through his wife, with the opening of these showrooms. The Wandsworth Company had passed their centenary, the family of Jones having been connected with them since their inception; and they were now one of the foremost commercial undertakings in the country. The Company were to be congratulated on their enterprise in erecting this modern and dignified building, where up-to-date appliances and equipment were displayed for the benefit of the many consumers in Wandsworth and Tooting. The service rendered by the Company was appreciated by 214,000 consumers, who received a night and day service which never failed—at a price as low as any in the Metropolis. The Wandsworth and District Gas Company employed 3,000 persons—and employed them under excellent working conditions; their wages bill amounted to £500,000 per annum. They were proud that the Company was giving housewives the opportunity of taking advantage of gas service in its most up-to-date form—and he hoped they would avail themselves of those facilities. These new showrooms would undoubtedly be of service to the consumers in the neighbourhood in illustrating how gas could be used economically in the home to the advantage of the public. That was the keynote of the Undertaking's business. Alderman Doland congratulated Tooting on the possession of this splendid new building and also all those responsible for its design and construction. There was, he observed, a great future for the Gas Industry in the life of the nation, and not only would the Wandsworth Company benefit by the provision of the new showrooms, but Tooting would accept and use the facilities thus provided for the mutual benefit of all. In conclusion, he wished all prosperity to "Mr. Therm," coupled with the name of Mr. Jones.

Mrs. DOLAND, who was presented with a bouquet by Mrs. C. M. Croft, graciously declared the showrooms open, and congratulated the Company on the marvellous display of appliances.

Mr. JONES thanked Mrs. Doland for the charming way in which she had launched their new venture, and remarked that the building had been designed by the Company's own staff, to whom he paid tribute for all the work they had put in.

The assembled company, which included Alderman and Mrs. Doland, other Aldermen and Councillors of the Borough Council, representatives of the local Rotary Club, Chamber of Commerce, and neighbouring gas companies, and prominent local residents, were subsequently entertained at luncheon in the demonstration room, Mr. F. H. JONES presiding.

The Loyal Toast having been duly honoured, Mr. C. M. CROFT (Chief Engineer and General Manager of the Wandsworth Company) referred with pleasure to the presence of so many distinguished guests on that occasion. This was the twenty-third showroom to be opened in the Company's area, he said, and nearly half-a-million people passed through them in the course of a year, of whom some 90,000 visited the original premises in Tooting. This was a very large number, and he wanted to assure them that the Company's showrooms were not merely available for the payment of accounts and the purchase of appliances, but also to be of service to them in their daily problems. When the new Civic Centre was opened recently an official brochure was published which showed that the Wandsworth Company was the largest industry in the Borough—the largest employers of labour in the district; and their employment was of a kind that was likely to be permanent. The staff and workpeople they appointed had the opportunity of becoming co-partners in the Undertaking and of becoming pensioners on retirement. They were very proud of their new showrooms, said Mr. Croft, which had been designed on a site which presented some difficulties to Mr. Butler, the Company's Architect; all the specifications were drawn up by the staff of the Company. They hoped they would be a credit to Tooting and would be of benefit to the residents of the Borough.

Alderman C. MILLS, in proposing the health of the Chairman, expressed the guests' very sincere thanks for the invitation to be present on that occasion. He had a great deal to do with the public lighting of the Borough, and had always received the greatest assistance and co-operation from Mr. Croft and those associated with him in an endeavour to give efficiency with economy in the lighting of their Borough, until they had to-day one of the finest lighting systems in existence. Referring to Mr. Jones, Alderman Mills observed that he had been Chairman of the Wandsworth Company for the past thirteen years and a Director for over thirty-three. Indeed, his family had practically controlled the Gas Industry in Wandsworth for over a century, which was a wonderful record. Mr. Jones was deeply interested in the welfare of the employees and in providing the best service to the consumer at the lowest cost; he was respected and loved by all.

The toast was cordially accepted to the accompaniment of musical honours, and Mr. JONES, in response, said he wished to regard the very kind things that had been said about him as intended for the whole of the Wandsworth Company. He was part of the Company, and he accepted all that had been said on behalf of the Company as well as himself. The Wandsworth Company, he said, gave him his first chance in life, and the part he liked best was going out on the works and talking to the people who ran them. They were all a very happy family, and the Company was served by a staff second to none, on whose behalf he thanked them for the kind way in which they had drunk the toast.

Labour Saving and Health

Lessons from South London Demonstration.

An instructive pointer to the problems in which women are mostly interested in relation to health and the home has been provided by the eleven weeks' series of the *Kentish Mercury* Food and Health Demonstrations which ended at Downham on May 14. During that period many thousands of people—the large majority of them women and, in the main, housewives—have attended these demonstrations, in which the South Metropolitan Gas Company have played a prominent part.

The attention with which the cookery demonstrations were followed at each session shows that the average woman welcomes the opportunity to learn of new dishes and new methods of serving those with which she is already familiar. The questions asked after each demonstration provided convincing testimony to the fact that cooking by gas can be made, not only more economical, more nourishing, and therefore contributing to the better health of the family, but also more interesting.

Indeed, the demonstrations showed that the days of perspiring labour in the kitchen are over and done with, now that gas cooking equipment has been scientifically designed to avoid it as well as to render cleaning and upkeep the minimum of labour.

One of the films shown by the Gas Company at each session amply reinforced this point. Its title, "The Smoke Nuisance," not only illustrated the dirt and discomfort caused by deposits from smoke belched into the atmosphere, and injury to health as well as the waste of money thereby engendered, but the film implied how the adoption of smokeless fuel and the use of other sources of heat can save labour both in the home and in the factory.

Altogether it may be said that the series of demonstrations was an outstanding success and must have done much to further the cause of gas in South and South-East London. The South Metropolitan Gas Company are to be complimented upon the important part they took in the demonstrations.

An "Ascot" Display at Bristol

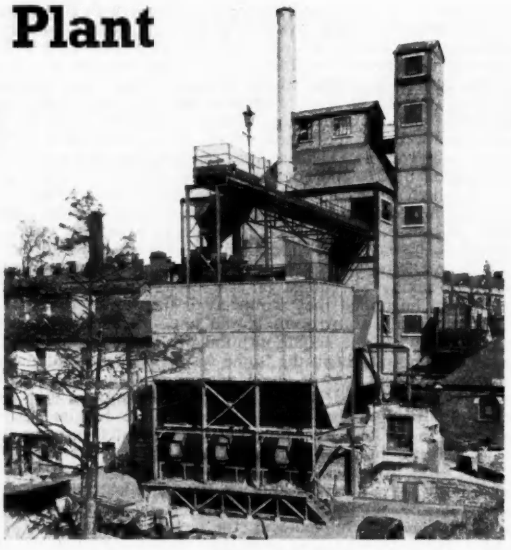
Above is the stand of Ascot Gas Water Heaters, Ltd., at the recent Annual Exhibition at Bristol. Of neat and attractive appearance, the display attracted a considerable amount of attention.

Glasgow Exhibition

In our brief report of the activities of the Gas Industry in the Exhibition, we omitted to mention that Messrs. R. & A. Main, Ltd., have a stand in the Palace of Engineering, as befits their status as a very important gas appliance manufacturing firm in Scotland. We shall have the opportunity of referring in more detail to this and other features at the time of the B.G.F. visit.

Results of the C.O.L. Plant at Abergavenny

We are indebted to Mr. A. D. Howells, Engineer and Manager to the Abergavenny Gas Department, for these particulars of the Department's new plant and its working results.



General View of the Plant.

In 1935 it was apparent the Abergavenny Gas-Works would have to be modernized to meet the ever-increasing demand for gas. The storage question had also become very acute. At this time there was a change of management, and the writer was appointed Engineer and Manager.

The first consideration was a new carbonizing plant, and after careful investigation it was decided the existing horizontal retorts should be replaced by continuous verticals. A tender by Messrs. Gas Chambers and Coke Ovens, Ltd., of Artillery House, Artillery Row, Westminster, S.W. 1, was accepted, and the plant has been in continuous operation since October, 1936, giving very satisfactory results.

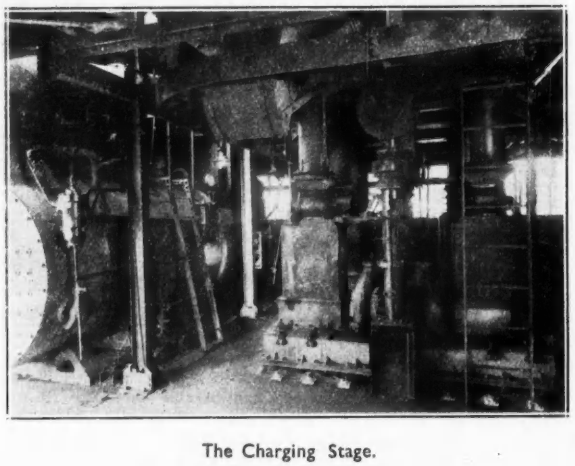
The new carbonizing plant, constructed at this time, comprizes: Coal handling plant; a bench of 6 40-in. C.O.L. continuous vertical retorts arranged in two settings of three retorts each; an independent battery of two step-grate producers for the heating of the retorts; and coke handling and screening plant.

Retorts.

The carbonizing plant has a nominal capacity of 24 tons of coal per day. Each retort is an independent unit, and between each setting is a ventilated division wall, so that any setting can be heated up or cooled down without interfering with the operation of the adjacent settings.

Each retort is constructed throughout of tongued and grooved bricks and is approximately 25 ft. high over all. The top section of the retort, in the zone where the cold coal enters and is preheated, is constructed of high alumina firebrick, as is the lowest section where coke cooling takes place, while the central section—*i.e.*, the actual heating zone, is built of the highest grade 95% silica material. Thus each section of the retort is built of the material best adapted for the particular stage of the process taking place therein.

Each retort is buttressed by vertical bonded stay walls, thus ensuring maximum strength, and these walls form the divisions between the heating flues.



The Charging Stage.

The bench bracing is of heavy section tied by heavy tie bolts, adequate provision being made for the controlled expansion of the setting during heating-up.

Hot producer gas is supplied to the bench from two independent step-grate producers connected to a common producer gas flue. Each producer is fitted with two steam-air injectors and producer doors, which enable the breeze made in the carbonizing plant to be gasified. Producer gas is supplied to each side of each setting through a damper-controlled connexion from the common producer gas flue, while the supply of secondary and tertiary air is controlled by graduated air slides.

The retorts are upwardly heated with vertical flues, thus combining the most effective system of heating with the maximum strength of construction. Provision is made for the controlled admission of so-called "tertiary" air to each heating flue, so that the correct temperature zoning can be attained to suit the particular coal being carbonized. Sight holes are provided at charging floor level, so that complete temperature inspection can be carried out from this level. Temperature control of any wall is effected very simply by adjustment of the single damper in the waste gas outlet from that wall.

The waste gases from each setting pass through a damper-controlled connexion to a common steel-cased brick-lined waste gas flue, which in turn is connected to the chimney and waste-heat boiler. The chimney is of steel, firebrick lined for its full height, and is provided with an automatic chimney draught regulator at its base.

Waste Heat Recovery.

The settings are non-recuperative, the heat in the waste gases being recovered by a Spencer-Bonecourt firetube boiler, designed for a working pressure of 80 lb. per sq.in. This boiler is situated at charging floor level, and is connected to the main waste gas flue which, as mentioned above, is steel-cased and brick lined. The boiler is of the natural draught type, and provision has been made by means of a producer gas augmentation flue to permit the boiler to be worked up to full load, irrespective of the load on the carbonizing plant. The steam raised in this boiler is sufficient to satisfy the requirements of the whole of the works, including the concentrated liquor plant.

Results Obtained.

The plant has now been working for over twelve months and has carbonized during that time a variety of coals, South Wales, Durham, and Derbyshire. It is giving trouble-free operation, and the whole of the work, other than coal handling to the overhead bunkers, is being carried out easily by one man per shift, while giving yields in excess of the guarantee figures.

The results obtained when carbonizing Blaenavon Nuts are as follows:

Coal throughput per retort	3·95	tons per day
Gas make per ton of coal	19,000	cu.ft.
Calorific value of gas	450	B.Th.U. per cu.ft.
Thermal production per ton of coal ..	85·5	

The make for the first full year of operation—April 1, 1937, to March 31, 1938—amounted to 81 million cu.ft., an increase of 24·6% over the previous year.

Ancillary Plant.

The next consideration was the ancillary plant—a new Livesey washer by Messrs. W. C. Holmes & Co., Ltd., Huddersfield, was installed, of 300,000 cu.ft. *per diem* capacity, and two exhausters,

each of 20,000 cu.ft. per hr., one 3-blade steam-driven set by Messrs. the Bryan Donkin Company, Ltd., Chesterfield, and one 3-blade steam-driven set by Messrs. Geo. Waller & Son, Stroud, replaced the existing exhausters.

Owing to the close proximity of the gas-works with the River Usk, a noted fishing river, great care had to be taken to avoid river pollution, and all ammoniacal liquor was loaded into rail tanks for disposal at great expense. To obviate this expense, a new cast-iron tar and liquor tank, with a capacity of 20,000 gallons, was installed. This tank was fitted with a weir and a steam coil was inserted so that very good separation of the liquor and tar was obtained, the separated liquor overflowing the weir into a separate compartment of the tank. The liquor from this tank is pumped into a liquor concentration plant.

The plant installed was the Thorncliffe Baldurie automatically-controlled type by Messrs. Newton Chambers & Co., Ltd., Sheffield. This plant enables concentrated liquor to be automatically produced without labour. This plant is working most satisfactorily and producing a liquor of 19% ammonia.

Storage was the next question to receive attention, and it was decided to dismantle the single lift 88,000 cu.ft. holder and erect a three-lift spiral-guided holder on the same site. This work was entrusted to the Fairfield Engineering Company, Ltd., Chepstow, and is now nearing completion.

OFFICIAL INAUGURATION OF NEW No. 2 WORKS AT STRETFORD

Foundation work for the new No. 2 Works was started in March, 1937, and the erection of the first section of the new retort house was started at the end of June, 1937.

Coal is brought to the new site by means of a siding connected with the existing works, a petrol-driven loco. being used for marshalling the wagons to the tippler. This is of the rotary type, electrically operated, the automaticity being such that the operator is enabled to complete the cycle of clamping, tipping, and unclamping a 20-ton wagon, within a period of 3 minutes. The tippler is housed in a dustproof structure mounted over a concrete receiving hopper.

The coal passes forward via a feed regulator and short elevator to an inclined belt conveyor, and thence to a horizontal belt conveyor which runs the full length of the retort house immediately above the coal bunkers, this method of coal transport being adopted as securing the threefold advantages of minimum creation of dust, minimum wear and tear of plant, and minimum noise of operation. Coal for stock can be diverted from the inclined conveyor to a stacking belt conveyor which is provided with special tripper and side wing conveyors for distributing the coal over the full area of store. Continuous storage bunkers are superposed over the two benches, and have a capacity of 48 hours untrimmed, thus no week-end labour is entailed to replenish the bunkers. Automatic doors are installed to regulate the feed of coal to the stoking machines.

Coke Handling.

Since coke still retains its premier position as the chief residual product of carbonization, its gentle and efficient handling remains an important feature in the economy of carbonization. The Le Fleuve coke conveyor besides conferring this advantage, also possesses the additional merits of low cost of production, low maintenance costs, and a penchant for low moisture content of the coke.

The troughs are made of cast iron fitted with Bearco liners. Centrifugal pumps in duplicate are used to circulate the flow of water along the troughs, and through the drainage grid to the settling tanks outside the retort house.

The coke is delivered from the receiving hopper under drainage grid to the top of the coke storage bunkers by means of two inclined belt conveyors arranged in sequence, with a coke cutter interposed between them, which can be utilized or by-passed as required.

One of the most interesting features of the installation is the imposing structure which houses the coke storage bunkers and screens, and the height to top of which above yard level is no less than 66 ft. The bunkers have a total storage of 430 tons, and this large capacity ensures that breeze formation and labour of operation are at the irreducible minimum.

The bunkers are surrounded by the coke screens, which are of the high-speed reciprocating type, and the whole is contained in a ferro-concrete non-corrosive structure, the bunkers being compartmented to grade the following sizes: 0 in.-½ in., ½ in.-1 in., 1 in.-1¼ in., 1¼ in.-1¾ in., the large size 1¾ in. and over being separated by scalping screen.

Coke is delivered to road vehicles or to railway wagons, over static and travelling debreezers respectively, and two Belle Isle bagging weighers and bagging platforms are provided on the lorry side of bunkers. Advantage is taken of the height of screen house, to position the 19,200 gall. storage tank for supplying water to the new works.

Coke can be stacked to a capacity of 2,650 ton by means of a horizontal belt conveyor provided with automatic tripper and fed from the aforementioned inclined belt conveyor.

The ashes from the retort house are elevated from the pit below the basement level by means of an electrically driven skip and are then automatically tipped into an overhead storage hopper, manual handling being thus at the minimum.

The main switchboard for the coal plant is fixed in the pump house at the end of retort house, and from this point all the various sections of the coal plant are controlled, arranged for sequence starting and stopping.

A separate switchboard is fixed in the house over the coke storage bunkers for controlling the various sections of the coke plant, also arranged with separate interlocking.

The electric supply throughout is 460 volts D.C.

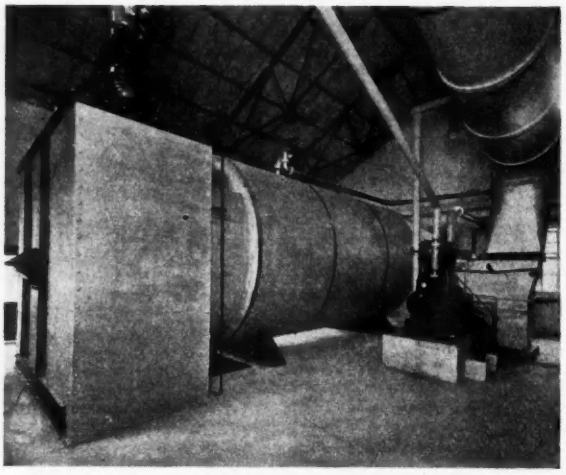
Carbonizing plant.

The carbonizing plant consists of two horizontal retort benches totalling 20 beds of 10 retorts 24 in. × 18 in. special D section × 22 ft. long. The retorts are built-up in 95% converted silica segments, and are set in 5 tiers, supported by 13 all-silica stay walls 6 in. thick. The tubular regenerators are of the three-row type, giving a very high regenerative efficiency, and all tubes can be inspected and cleared of dust from the front wall.

The producers are 12 ft. deep floor to floor and provided with non-clinkering screen-bar-grates. Each producer is provided with

a curtain wall and two producer-gas dampers operated from the back, consequently the depth of incandescent fuel is always constant and the producer-gas definitely controlled to each half of the setting.

A special fireclay duct is provided for the purpose of drawing off surplus gas to be used as desired for the dilution of the straight coal gas.



Waste Heat Boiler.

The bench fronts are faced with special hard insulation brick, and the whole of the bench top is finished with a course of solid insulation brick 4½ in. thick.

The main flues from each bench join together into a cross flue which delivers the waste gases either to a 90 ft. high chimney or to the waste heat boiler. This is of the standard horizontal fire-tube induced-draught type and generates steam at 120 lb. per sq.in. gauge pressure, superheated to a final temperature of 510° F.

The benches are equipped with improved Congdon scrubber standpipes whereby it is possible to control the pressure conditions in the retorts to within 1-50th in. W.G., and furthermore there is no labour involved in cleaning, such as is necessary with ascension pipes. Each standpipe is in valved communication with 5 retorts, each of which is in a different stage of distillation. A stream of liquor is maintained down each pipe, and deflector plates are provided immediately over each valve to deflect the liquor on to the face of valve when open and to prevent liquor entering the mouthpiece. Each standpipe is provided with a liquor seal box having a Weir type overflow, leading, via the liquor return mains, to two separating tanks situated outside the retort house. Adjacent to the separating tanks are tar and liquor pumps in duplicate. Either pump of each pair can be used for returning liquor to the sprays or for pumping tar to the main well.

The foul mains are 24 in. and 30 in. dia. composed of ¼ in. thick welded steel plates, the two governors being of Cowen's 16 in. diameter size and complete with Brown & Holton remote control gear. A safety automatic relief and vent pipe is fixed between the two benches.

The retort house is 58 ft. span and 243 ft. long and is prepared for extension by a temporary gable at one end. The framing generally consists of rolled steel joist stanchions with horizontal steel tees to support and reinforce the brickwork filling. The roof covering is of Turners' Trafford tiles.

The retorts are charged and discharged by two F. A. simultaneous stoking machines of the improved type. The chains of the machines have distribution ploughs cut on the side of the chains to permit of more even distribution of the charge and increased weight. The average weight of coal per charge on recent tests is 16 cwt.

The "Super" type horizontal water-tube condensers are provided, capable, when working in parallel, of cooling 300,000 cu.ft. of gas per hour from a temperature of 188° F. to within 5° of the water inlet temperature, which ranges from 55° F. to 60° F. with a total cooling surface of 16,246 sq.ft.

Tar Fog Extraction.

An electro-detarrer is installed at the inlet of the exhausters. It comprises a 7 ft. 6 in. dia. gas treater and a high tension generator set, the latter being housed in a section of the exhauster house building. In view of the complete reliability of the plant no stand-by equipment is provided. The gas-treater is of the standard type in which stainless alloy-steel discharge-electrode wires are disposed along the axes of 6 in. i.d. collecting tubes and are tensioned between frames carried on a rigid antiswing central electrode, the whole being supported from a single quartz insulator. The electrical equipment comprises two H.T. generators driven in line by a motor operating on the works D.C. supply. This system obviates the use of alternators, transformers, and rectifiers and power is generated permanently free from interference with local radio reception. The power-consumption is only 4 kW and the operating voltage about 26 kV. The plant as a whole is provided with a foolproof system of safety interlocks.

The electro-detarrer extracts over 99·5% of the tar fog in the gas and ensures that the ammonia scrubbers and the purifiers are operating under ideal conditions, thus, in effect, considerably increasing their capacity and efficiency.

The house is divided into two sections, one housing the electrical equipment for the detarrer, whilst the other half contains the meter and exhausters. The meter is of the Connersville type of 300,000 cu.ft. per hr. capacity and is installed on the inlet to exhausters. The meter is equipped with P.V.T.T. recorder in addition to the usual fittings. A novel feature of the meter is a tachograph, which shows the rate of gas throughput in terms of thousands of cubic feet per hr., while above the dial a chart records the information throughout the whole period the meter is working.

Two Connersville exhausters have been installed, designed for working against a pressure difference of 55 in. W.G., when running at a speed of 410 r.p.m.

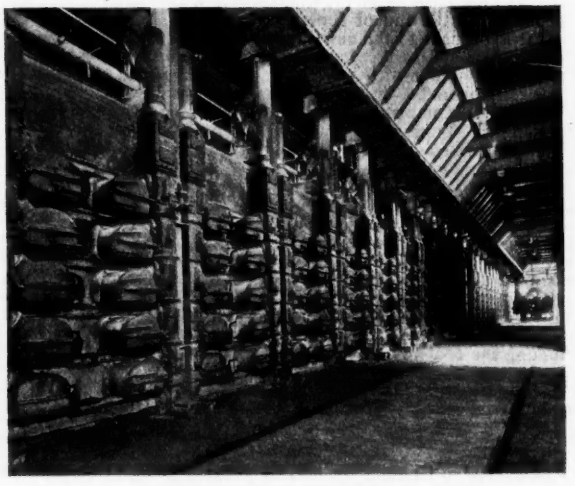
The gas, on leaving the exhauster house, passes through a 30 in. main to a Livesey washer, 30 ft. long × 9 ft. wide × 3 ft. 6 in. deep, containing 60 tubes, so that in the event of there being any interruption in the operation of the electrical detarrer the rest of the purification plant is safeguarded against consequent fouling.

For ammonia washing, two "Multifilm" brush washers have been erected, each having six chambers, giving a capacity of 600,000 cu.ft. of gas per hr., with the two units working in series.

Dry Purification.

Oxide purification is carried out with four overhead main boxes being 40 ft. × 30 ft. × 12 ft. deep, complete with supporting structure, lifting apparatus and oxide plant, having a capacity of 7,000,000 cu.ft. *per diem*. These boxes are of entirely welded construction. Internal surfaces of these purifiers are protected with a coating of asbestos and cement, also the individual box lids are coated with this mixture of asbestos cement to a depth of approximately 1½ in. Six tiers of oxide are arranged internally in each of the boxes and each box is provided with a patent internal distribution valve. These purifiers were constructed in 1936 and were put into operation at the end of that year.

In addition there are four old C.W.G. purifiers which are now used as catch boxes.



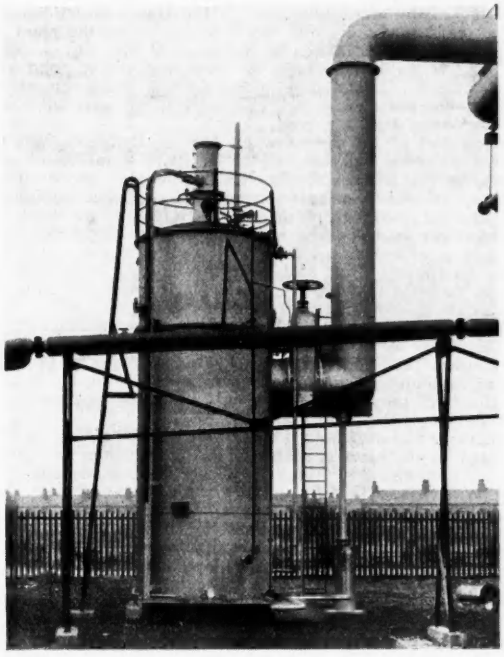
Retort Bench—Charging Side.

The liquor concentration plant is capable of dealing with 700 gallons hourly of crude liquor, and produces concentrated liquor of 20% strength by weight. The still is of the bubble tray type, made in cast iron, and the heat exchangers are of concentric tube design. A dissociator is provided to remove carbon dioxide and hydrogen sulphide from the liquor to prevent crystallization of the final concentrated liquor. The plant is automatic in operation.

Benzole extraction, naphthalene removal, and dri-gas plants were installed in 1932 and are of the rotary brush type, each capable of dealing with 5,000,000 cu.ft. *per diem*. A central engine operates the benzole washers, and the dri-gas plant washer.

Gasholders.

The total storage capacity of the four gasholders is 4,180,000 cu.ft. No. 1 Holder is a three lift spiral guided gasholder of 100 ft. diameter, and 540,000 cu.ft. capacity. No. 2 is a three lift guide framed holder of 100 ft. diameter, and 540,000 cu.ft. capacity. The tanks are of brick and puddle with very low cones. No. 3 Holder is a four lift standard guided holder having a capacity of 1,100,000 cu.ft. in brick tank.



Electro De-tarrer.

No. 4 Holder is situated in Dane Road, Sale, some 2¼ miles from the works, and is a four lift spiral guided gasholder in steel tank, and was put into commission in March of this year, capacity 2,000,000 cu.ft. The holder and steel tank are of welded construction throughout, and the total weight of steel work is approximately 880 tons.

This holder is fitted with patent overflow and return ducts to prevent external flooding, gas blowing, and removal of oil film.

Principal Contractors.

Robert Dempster & Sons, Ltd., Elland, Yorks.	Retort House, Carbonizing Plant, Coal, Coke, Ash, and Oxide Handling Plant, Coke Screening Plant.
W. C. Holmes & Co., Ltd., Huddersfield.	Condensers, Meter, Exhausters, Livesey Washer, Multi-Film Washer.
The Whessoe Foundry and Engineering Company, Ltd., Darlington.	W-W.D. Electro-Detarrer.
Spencer-Bonecourt, Ltd , London.	Waste Heat Boiler and Fan.
Oxley Engineering Company, Ltd., Leeds.	Welded Purifiers and Gasholder.

INAUGURAL CEREMONY.

The new Works were officially declared open by Alderman W. WARDLE, J.P., Chairman of the Board, on Thursday, May 19. By invitation of the Board about 150 guests assembled for luncheon at the Stretford Town Hall, Alderman WARDLE presiding.

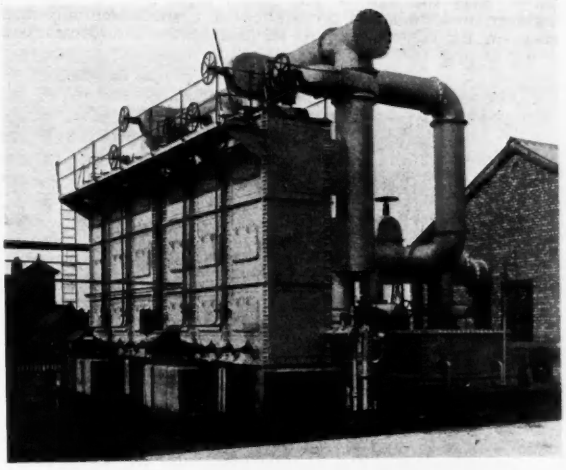
Mr. GEORGE DIXON (Vice-President of The Institution of Gas Engineers), in proposing the toast of "The Stretford and District Gas Board," said that the new works had been constructed in the way that one would expect them to be by those who were responsible for their installation. While every attention had been paid to the convenience and comfort of domestic and industrial consumers, and to the solution of the smoke abatement problem, there was also abundant evidence that every possible effort had been made to establish thoroughly comfortable and easy conditions of working for the men who were engaged upon the plant. Stretford had given a great deal to the Gas Industry during many years past. He had the privilege of being trained by the father of the two Carrs present that afternoon. It was a privilege which he would appreciate throughout the whole of his life; and it was with more than ordinary pride that he asked the assembled guests to drink to the continued prosperity of the Stretford Gas Board, coupled with the name of Alderman Wardle, its Chairman.

Alderman WARDLE, responding to the toast, said that if 17 years ago someone had said that in 1938 the capacity of the works would have been doubled he would have been looked upon as a super-optimist. The result had been due to the faith of one man who pledged his reputation to achieve success. Colonel Carr took on what appeared to be an insuperable job; he took it in hand meaning to make a success of it. It might be a coincidence, but the period during which the Board had been in existence had seemed to be a period of renaissance or an awaking of a revival of the Gas Industry. A great deal of the credit for that state of things was due to the policy adopted and carried out by the Board under the guidance of their Consulting Engineer. He set on foot many things which at one time were not regarded as being entirely sound in their conception. He was one of the first advocates of cheap gas for industrial purposes; and this policy was regarded in some quarters as being a matter which would lead ultimately to financial suicide. Colonel Carr persisted with the idea, backed up by the Board, and it was now obvious that the policy was fully justified. The Board's Undertaking had developed in regard to both industrial and domestic supplies.

There had been an increase, during 17 years, of 74% in the supply to domestic consumers; but of course domestic supply was more or less a matter which naturally increased. The ordinary development of housing had brought with it its gas load, and the Board had had their share of the increased business. The problems arising out of domestic supplies were comparatively simple to solve; but when they turned to the industrial side of supply that was a business and a load which had to be searched for and cultivated. Their industrial friends had to be convinced that the service which was being offered was a sound proposition for them to accept. It was only by an intensive study of the requirements of their industrial friends that they were enabled to convince them that what they were saying was true. One of the bases of the success which had attended the efforts of the Board was that the promises they had made had always been fulfilled.

Three or four years ago when they were contemplating the establishment of the present extension to the works, they first of all had the idea of extending the old retort house, but with a vision which he thought was to be commended it was decided that such an extension would not serve for any great length of time.

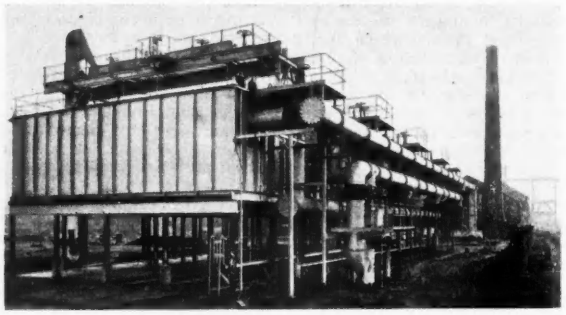
There was only one regret the Board had in regard to the matter. When they considered the financial aspect of the new scheme, and considered whether the increased capital outlay could be covered by the increased business, as they were convinced it could be, they thought they would be able to do it all without increasing the price of gas; in fact, they were sufficiently optimistic to think that perhaps they would be able to reduce it. Their regret was that they had been frustrated, as every gas engineer knew, by the Coal Selling Schemes, about which the less said the better. When it was found that the raw materials were costing anything from 30 to 50% more than previously, then all the efficiency in the world, as far as he could see, could never bridge the gap. Therefore, they had been compelled, much against their wills, to ask for an increased price; but if the opportunity arose



Multi-Film and Livesey Washer.

to restore the price to the previous level they would do it without the slightest hesitation.

There were within the borders of the district two industrial areas which were a long way from being saturated. They had with them, on that occasion, Sir Frederick West, of the Ship Canal Company Directorate He represented an industrial area of virgin soil which was waiting to be developed, and no effort would be spared on the part of the Stretford and District Gas Board to



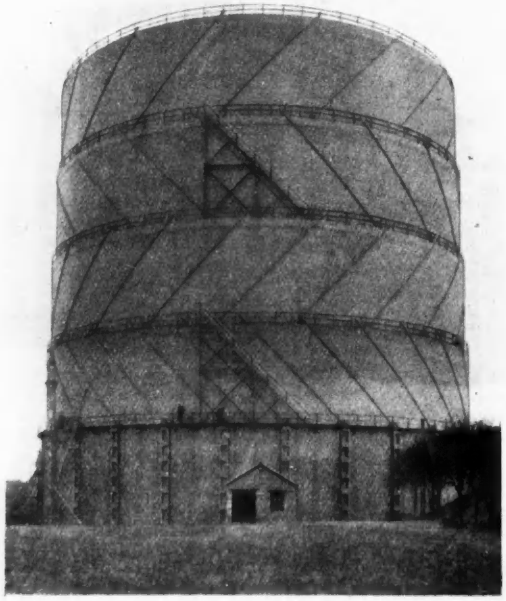
Welded Purifiers and Oxide Plant.

do whatever they could to induce firms and industries to take up positions in that area. The motto of the Stretford Gas Board might seem to be somewhat hackneyed, but nevertheless it was true—namely, "Service and Efficiency."

He would like to pay a tribute to the Engineer of the Board, Mr. James Carr, for his unwearying energy in the carrying out of the job, and for the keenness he had shown in the erection and the organization of the new Works. Mr. F. G. Symon, the Works Manager, had spared neither time nor energy to ensure its success, and the same could be said also of Mr. T. H. Pardoe, the Industrial Expert.

"The Contractors."

Councillor R. HALL (Vice-Chairman of the Board) proposed the toast of "The Contractors." As the Chairman of the Board had stated, it was more than two years ago since it was brought very plainly to the notice of all concerned that very strenuous endeavours must be made to solve the problem of the supply of good and cheap gas in sufficient quantity when the plant which they already possessed was over-burdened. The necessary formalities having been gone through, and the sanction of the Ministry having been obtained, tenders were received and the work was commenced in February of last year. Between February and the end of May the staff of the Board, supervised by their own Engineer, undertook the preparation of a site which was made ready for the contractors. At the end of the period mentioned



Welded Gasholder (No. 4).

Messrs. Robert Dempster & Sons, Ltd., were ready to commence the erection of the new works. The contracting firms had faced the difficulties of obtaining steel at a time when that material was difficult to obtain owing to the demands made by the Government Re-armament Programme. The way the Contractors had been able to overcome those difficulties was really wonderful. There had been no delay in any section of the work from the middle of June when it was first put into operation by Messrs. Robert Dempster & Sons.

As those who were concerned in the Gas Industry would be aware, the work of erecting the first portion of the plant must of necessity be undertaken in advance of the rest. Messrs. Dempster brought the whole of their work to a point where other contractors could come in and do their share, thus showing that they had not merely their own interests at heart but also the interests of the Board as well.

At the end of the period when Messrs. Dempster were in a position to offer facilities for the ancillary plant to be added Messrs. W. C. Holmes & Co., Ltd., were able to go on with their part of the work and accomplish it with the minimum of delay and the maximum of efficiency. In regard to a Works such as that under consideration one must realize how necessary the dove-tailing of one firm's work with another's was. The whole of the contracting firms had pulled together in a splendid way in order to bring to fruition a work which could only have been done by the give-and-take necessary.

There had been a W.-W.D. electro-detarrer precipitator plant installed by the Whessoe Foundry and Engineering Company, Ltd., and a waste heat boiler and fan by Messrs. Spencer-Bonecourt, Ltd., of London. Each of these firms had, in turn, fitted in with the scheme of things, and it was only right that everyone should know how well they had done so.

Something had also been done in which Colonel Carr had been interested in in the past—namely, the introduction of Congdon scrubber standpipes, by Messrs. Aldridge & Ranken, Ltd.

Mr. W. H. HANDLEY (Managing Director, Messrs. Robert Dempster & Sons, Ltd.), in responding to the toast, thanked the proposer, on behalf of the contractors, for the very kind and appreciative remarks which had been made concerning them. The difficulties referred to were not by any means imaginary. The Re-armament Programme had so disorganized the steel works that they did not know from one day to the next when they were going to receive their material. Nevertheless, the plant had been completed in almost record time. The mutual object of all the contractors had been to produce a modern and up-to-date plant which would meet the requirements of the very progressive Stretford and District Gas Board.

"The Visitors."

Colonel W. M. CARR, O.B.E., T.D. (Consulting Engineer to the Board), proposed the toast of "The Visitors." He was particularly pleased to have the opportunity of doing so because among the visitors were not only many of his friends in the Gas Industry itself but also many whom the Board were privileged to serve as an undertaking He had been privileged to serve them as the Chief Official of the undertaking for 15 years, and he knew that those who had succeeded him were now also serving those friends to the best of their ability.

Reference had been made to the enormous increases in coal prices. He could only hope that the coal industry would appreciate, before it was too late, that they might do irreparable damage to the Gas Industry not only in Stretford but throughout the length and breadth of the land if they held the view that public utility undertakings possessed unlimited purses. The manufacturer to-day required fuel which could be obtained easily. He wanted gas, and not imported oil. He wanted the most up-to-date appliances, and the best controlled heat to assist him in obtaining the best production. The crude methods of, say, 20 years ago had to go, and they had to give the manufacturer a fuel made from coal. The Gas Industry was the coal industry's best friend. Unless the coal industry was willing to collaborate and enable the Gas Industry to produce gaseous fuel cheaply irreparable damage would be done generally.

Mr. E. WATSON-SMYTH (Director, Messrs. Taylor Bros. & Co., Trafford Park), in responding to the toast, said that the association of his firm with the Stretford and District Gas Board had always been one of the most pleasurable description.

Councillor W. P. JACKSON, J.P. (Chairman of the Manchester Corporation Gas Committee), also responded to the toast. He referred to an attempt which was to be made by the City of Manchester in the very near future to obtain some form of Government legislation which would make it impossible for raw coal fuel to be used, even in domestic houses. A motion was shortly to come before the Manchester City Council, and he had some responsibility in engineering it, to forbid anybody using raw coal fuel within a radius of half a mile of the Manchester Town Hall. He was appalled, a little while ago, on going to the top of the very handsome new extension to the Manchester Town Hall, to see that within a very small area there were hundreds of chimneys emitting thick black smoke which was a menace to the public health,

Wales and Monmouthshire Association of Gas Engineers and Managers

The Annual General Meeting of the Association was held at Aberdare on May 19, under the Presidency of Mr. J. STEPHENSON, Engineer and Manager of the Aberdare and Aberaman Consumers' Gas Company.

The business session was held in the Memorial Hall, Seymour Street. Apologies for absence were received from the Presidents and Secretaries of kindred Associations and others, including the Hon. Secretary, Mr. Octavius Thomas (Penarth), through ill-health. The PRESIDENT said he personally greatly regretted Mr. Thomas's enforced absence, since his association with him was a very long one; this occasion was only the second that Mr. Thomas had been absent since the commencement of the Association, and there was no need for him to say how indebted they were to Mr. Thomas for the continued progress of the Association.

It was agreed unanimously to send a telegram to Mr. Thomas containing greetings and best wishes from the members of the Association and stating that they were all looking forward to seeing him at the next meeting.

The PRESIDENT then referred to the deaths since the last meeting of two of the members of the Association in Mr. J. E. Kenshole, who for many years was Chairman of Mr. Stephenson's Company and a Founder Member of the Association, and Mr. W. Stanford (Newport), who was an Honorary Member.

Members stood for a few moments in silence as a tribute to their memory.

The ASSISTANT HON. SECRETARY (Mr. Wilfred Jones) read the minutes of the last meeting, which were confirmed and signed, and thereafter the following member, associates, and student were elected on the proposition of Mr. D. WALTER DAVIES (Tredegar): *Member.*—Mr. Thomas Porter (Engineer, Manager, and Secretary of the Cinderford Gas Company). *Associates.*—Messrs. Herbert Henry Camden (Cochranes (Middlesbro'), Ltd.), W. A. Lowe (Donald Macpherson & Co., Ltd.), James Rounds (Cannon Iron Foundries, Ltd.), Charles Henry Wilson (W. & H. Wilson, Ltd., Leeds). *Student.*—Mr. Kenneth E. Muir (Pontypridd). Mr. A. W. WILLETT (Builth) seconded their election.

The thirty-third Annual Report of the Council was then read by the ASSISTANT HON. SECRETARY. This stated that during the year six members, four associates, and one student joined the Association. Resignations accounted for two members and one associate, and one member died during the year. At the end of the Association's year the membership, therefore, was 90 members, 4 honorary members, 62 associates, and 1 student.

The report was adopted on the proposition of Mr. F. DUPONT (Brecon), seconded by Mr. F. C. WHITE (Blaenavon).

Election of Officers.

The following officers were elected for the ensuing year:

President.—B. Taylor (Quaker's Yard).
Vice-President.—R. L. Aspinall (Barry).
Members of the Council.—J. Robb (Chepstow) and D. Muir (Pontypridd).
Treasurer.—J. H. Canning, O.B.E., J.P. (Newport).
Secretary.—Octavius Thomas (Penarth).
Assistant Secretary.—Wilfred Jones (Cardiff).
Auditors.—J. H. Jones (Dowlais) and S. Walker (Porthcawl).

Referring to the officers just elected, the PRESIDENT said how glad they were to see Mr. Canning back again after his accident. Mr. CANNING briefly replied, thanking the members for their kind letters of sympathy received during his indisposition. In proposing the re-election of Mr. Thomas as Secretary, Mr. H. D. MADDEN (Cardiff) observed that he had asked to be relieved of those duties but the Council would not hear of it. They had, however, appointed Mr. Wilfred Jones as Assistant to Mr. Thomas. In seconding, Mr. W. H. JOHNS (Swansea) said that he was very glad Council had been able to persuade Mr. Thomas to remain in office. The PRESIDENT expressed the gratitude of the members to Mr. Wilfred Jones for the manner in which he had helped Mr. Thomas.

It was unanimously agreed to make the usual contribution of ten guineas to the Benevolent Fund of The Institution of Gas Engineers.

Presidential Address.

Mr. STEPHENSON then delivered his Presidential Address, which will be published in a subsequent issue.

In proposing a hearty vote of thanks to the President, Mr. CANNING said they had all listened with great attention and interest to Mr. Stephenson's Address. At the outset the President had said that on considering the list of former Presidents he was filled with foreboding, and went on to refer to the difficulty of finding new material to form the subject of Presidential Addresses. But the President had in fact no cause for this foreboding; he had produced an Address fully worthy of their Association. He had brought forward a mass of valuable matter and what he had told them could only have the effect of encouraging them to forge ahead. In that way he had pointed to the value of research in bringing those early germs to fructification. He was glad the President had emphasized the high prices now obtaining for coal, and while it was amusing now to read of Mr. Franklin's complaint in 1913 regarding the high price of their prime commodity, the price then obtaining being 11s. 10d. per ton, to-day the position was really most serious.

The vote of thanks, which was seconded by Mr. H. MATTERFACE (Monmouth), was carried with acclamation. The PRESIDENT briefly replied.

A Paper on "Distribution and Sales Methods at Port Talbot" was then given by Mr. E. M. Edwards, Engineer and Manager of the Port Talbot Gas Department. This, together with a report of the discussion will be published at an early date.

This concluded the business session of the meeting. Mr. JOHNS' proposition that a hearty vote of thanks be accorded Mr. Stephenson for the able manner in which he had presided was carried with acclamation and suitably acknowledged by the PRESIDENT.

Luncheon.

The company then adjourned to the Boot Hotel, Aberdare, for lunch, the Chair being taken by the PRESIDENT, who was supported by the Chairman, Mr. E. D. Williams, and Directors of the Aberdare and Aberaman Consumers' Gas Company, and Councillor J. R. James, Chairman of the Aberdare Urban District Council.

The Loyal Toast having been honoured on the call of the President, Mr. J. H. CANNING proposed "Prosperity to Aberdare," observing that in South Wales one was unfortunately only too familiar with the town that had sold its soul to industrialism, and it was therefore very pleasant on this his first visit to Aberdare to find that the town had managed to keep its soul intact. Few had kept their town and streets in such a beautiful state as Aberdare, and that reflected the greatest credit on the Council, who carried out their duties in a most efficient manner. Among the notable people who had been born at Aberdare was "Caradoc," leader of the *Cor Mawr*, or Great Choir, which won fame for Wales in all parts of the world. Another was William Thomas Lewis, who later became Lord Merthyr. That the town

was enterprizing no one doubted, and he had learnt that day that as far ago as 1898 the citizens could boast of a motor service. That was before the advent of the magneto, and he believed that, with the possible exception of London, represented the earliest motor service in the country. The town had, in common with all South Wales towns, been going through a depression and had borne it with commendable bravery. He was sure that courage would carry them through, and already new industries were coming to the town.

In reply, Councillor JAMES thanked Mr. Canning for his kind words of encouragement, and went on to refer to the President. Mr. Stephenson, he said, was a very active and good citizen of Aberdare, doing yeoman service in many directions. Mrs. Stephenson was also a very valued citizen, who was always prepared to do everything she could for the town. Aberdare had been very honoured by the presence of the Association; it was the first time a conference of such magnitude had been held in the town. In conclusion, he thanked the Association for having conferred the honour of the Presidency on one of their townsmen.

"The Wales and Monmouthshire Association of Gas Engineers and Managers" was honoured on the call of Mr. E. D. WILLIAMS, who stated that he had been associated with the Aberdare Company for a great many years, and since its acquisition by the United Kingdom Gas Corporation he had held the office of Chairman in succession to the late Mr. Kenshole, whose services to the Company had been so valuable. He was fully aware of the great assistance they all derived from the Association, and after his experience on the Golf Links the previous day he was quite prepared to believe that the motto of the members was "Work Hard and Play Hard."

The PRESIDENT, in the course of a brief reply, said it was indeed gratifying that his own Chairman should have proposed the health of their Association, for Mr. Williams was a most valued member of the Board. He went on to refer to the benefits accruing to the members of the Association, and concluded by calling attention to the happy relations that had always existed between the Aberdare Company and the Local Council.

Mr. H. D. MADDEN then presented the Upjohn and Dean Cups in connexion with the Golf Meeting, to which reference is made below.

The Golf Meeting.

The half-yearly golf meeting was held the day prior to the annual meeting, and play for the Upjohn and Dean Cups was thoroughly enjoyed over the course of the Aberdare Golf Club. The results were as follows:

UPJOHN CUP.

W. Clark Jackson	72 – 4 = 68
F. D. Drake	79 – 10 = 69
Joe Sadler	88 – 18 = 70
W. M. Fox	89 – 14 = 75
D. W. Rees	80 – 4 = 76
H. Matterface	91 – 15 = 76
F. Boardman	88 – 11 = 77
C. L. Bury	94 – 17 = 77

Sealed Hole Handicap won by Eric Jones.

DEAN CUP (BOGEY SINGLES).

E. D. Williams (all square)
F. D. Drake (one down)
D. W. Rees (one down)

The usual informal dinner of the Golf Association was held at the Park Hotel, Cardiff, the same evening, the Chair being taken by Mr. R. J. Auckland, who in congratulating the winners expressed the indebtedness of the Association to the officials of the Aberdare Golf Club for having placed their fine links at their disposal. They were delighted to have with them that evening the Captain of the Aberdare Club, Mr. W. R. Davies, and Councillor J. R. James, Chairman of the Aberdare Council. A special toast to Mr. Octavius Thomas, who was very much missed, was heartily accorded on the proposition of Mr. J. H. Canning. Mr. Joe Sadler, to whose indefatigable exertions, carried out with unfailing good humour, the successful organization of the meeting was due, was warmly thanked on the proposition of Mr. Auckland, who also called attention to the good offices of Mr. Wilfred Jones. Mr. Auckland was thanked for his able chairmanship at the conclusion of a very enjoyable evening by Mr. Prosser Jones.

Gas Undertakings' Results

Associated Gas and Water.

The report and accounts of Associated Gas and Water Undertakings, Ltd. (of which Mr. W. H. Bennett is Chairman and Managing Director), cover the year ended March 31, and show a net revenue for the twelve months of £59,419, or, with the amount brought forward, a total sum available of £69,690. The dividend on the ordinary shares is at the rate of 5% for the year, which will leave an amount to be carried forward of £17,564—£7,300 more than was brought in. The capital issued amounts to £1,709,535, and there is £500,000 of debenture stock; and the investments in subsidiary companies, and in other companies, appear as a net figure at £2,375,571. On the other side, there is a secured bank loan of £220,270. Against this, amounts due by subsidiary companies figure at £112,489. The holdings in subsidiary gas and electricity undertakings are shown, and the companies named number seventeen. During the year a majority interest has been acquired in the Barnstaple, Burgess Hill, and Ilfracombe Gas Companies.

Hyde.

Satisfactory working results were reported at the Annual Meeting of the Hyde Gas Company (a constituent undertaking of the United Kingdom Gas Corporation, Ltd.), held on April 30, with Mr. G. F. Drinkwater, J.P., C.A., Chairman of the Company, presiding. It was stated that during the twelve months the total number of appliances sold and fixed was 1,176, of which 813 were cookers. It was recommended that the maximum statutory dividend be paid on all classes of shares and stock. The report was unanimously adopted, and Messrs. M. H. Tetley and J. T. Brown were re-appointed Directors.

Imperial Continental.

The accounts of the Imperial Continental Gas Association are for the year ended March 31, and they embrace the trading results of the Association for the 114th year of its commercial activity. The balance at credit of profit and loss account for the year is £427,686, and adding the sum brought forward gives a total available for appropriation of £927,969. A dividend of 10% for the year will leave a balance to be carried forward of £516,369, or £16,000 more than the sum brought in. Interesting details of the operations of the Companies in which the Association is interested are appended to the report. These include four undertakings in England—one of them Edmundsons Electricity Corporation, Ltd. In the Belgian undertakings in which the Association is interested, increases in sales of gas and electricity have been general.

Primitiva Holdings.

The accounts of Primitiva Holdings, Ltd., are made up to April 30, and they show a net profit of £80,828, or, with the balance brought in, a total available sum of £204,671. A dividend on the ordinary stock at the rate of 3½% will leave £123,285 to be carried forward—practically the same sum as was brought in. Mainly because of increased income received from the principal subsidiary Company, the Primitiva Gas Company of Buenos Aires, Ltd., revenue shows an improvement of some £4,544. This has been offset to the extent of £2,279 by the provision for National Defence Contribution. The net profit, at £80,828, compares with £78,646 in the previous accounts.

Stalybridge.

After making allowance for working expenses, interest on loans and sinking fund contributions, rents, rates, income tax, &c., the profit of the Stalybridge Gas Department amounted to £980, compared with a profit last year of £1,006. In spite of increases in wages and materials, particularly coal, the Department has been able actually to lower the cost of gas into holder by 0·3d. per 1,000 cu.ft., now standing at 12·7d. per 1,000 cu.ft., arrived at by taking all the charges against manufacture, maintenance of works, and dry purification, from which the receipts from residuals are subtracted. The amount of gas sent out was 162·4 million cu.ft., a slight increase over last year—viz., 0·6%. The gas consumption, however, during the past three years has been very seriously affected by the building of new houses for slum clearances; all the families who have been installed in the new houses were comparatively good gas consumers. The Housing Committee's policy has been, and still is, the fitting of electric lighting, a solid-fuel grate, and gas-heated wash-boiler. It is therefore estimated that an annual loss of 1 million cu.ft. per 100 houses cleared is sustained by the Gas Department. During the year ended March 31, 1938, a decrease in domestic consumption amounting to 6·7 million cu.ft., and an increase in industrial consumption of 8 million cu.ft. have taken place. The industrial consumption now amounts to 41% of the total output. A small increase for the second year in succession has been obtained from public lighting, which shows an improvement of 9% during the last two years.

BOSTON ENTERTAINS

The Eastern Counties Association

After an interval of some 36 years, the members of the Eastern Counties Gas Engineers' and Managers' Association again visited Boston on Thursday, May 19, for their Half-Yearly Meeting.

Since the Association's last visit there has, outwardly at least, been little change in Boston itself, though the spirit of progress is everywhere in evidence. As for the Association, time has taken its inevitable toll, but while, on looking back, the loss of old friends was deeply regretted, there were many new ones to be greeted; for the Association has grown, and all of last week's functions drew crowded and enthusiastic attendances.

Indeed, it was under the most pleasant circumstances that those who had not visited Boston before made acquaintance with this ancient borough, whose famous "Stump" has stood sentinel over the town for nearly 500 years, and whose other ancient buildings and narrow streets combine to give it an attraction peculiarly its own. They found that, to quote the words of the Mayor, Councillor J. H. Mountain, in welcoming the members, though proud of its past, Boston nevertheless looks forward to the future, as befits a town whose products have world-wide fame and which, as the nearest port on the East Coast to the industrial Midlands, enjoys an ever-increasing share in the commerce of the country.

They found, also, a Gas Company both able and determined to support to the full a policy of development such as the words of the Mayor indicate. The President of the Association, Mr. W. C. Chapman, who is Engineer and Manager of the Company, received the members at the Works during the morning, and later in the day, at the business meeting, described them in some detail. There was thus ample opportunity of learning what the Company have done, and are doing, to give the borough that service which only gas at its best can give. They found a works well ordered and equipped to do what may be required of them, and bearing the signs of efficient management and that whole-hearted support of the Board which is a vital factor in the full success of any gas undertaking. The Chairman of the Company, Alderman T. Kitwood, J.P., Vice-Chairman of the Holland County Council, showed himself to be just what a Gas Company Chairman should be; and among the other members of the Board there is, of course, a very old and valued Eastern Counties friend, Mr. R. G. Shadbolt, who has had much to do with the policy of development pursued by the Boston Company, and who was present throughout the proceedings to support the President in entertaining the visitors.

A Highly Efficient Company.

At the conclusion of the works inspection there was luncheon in the Assembly Rooms, at the invitation of the Chairman and Directors of the Gas Company, with Alderman KITWOOD in the chair.

Col. J. KENNINGTON (Chairman of the Grimsby Gas Company), in proposing the toast of "The Chairman and Directors of the Boston Gas Light and Coke Company," acknowledged the warmth of the welcome that had been extended to the visitors. He referred to the splendid order and up-to-date equipment of the gas-works. Such evidence as they had seen of the highly efficient state of the Company and the excellent service that was given to the town reflected, he said, sound management over many years. The Board had adhered to a policy of continuous development. The price of gas was very low, particularly bearing in mind the size of the town and its distance from the coalfields. The Chairman was held in high esteem, not only in Boston, but throughout the whole County of Lincolnshire. A good Company deserved a good Engineer and Manager, and in Mr. Chapman they had such an officer. He was greatly valued in the Gas Industry, and the Association were proud to have him as their President.

In sincere terms, Alderman KITWOOD acknowledged the honour that the Association had done the Company, not only by electing Mr. Chapman their President, but also by coming in such large numbers to see what the historic town of Boston had to show them, and thereafter Mr. J. H. TROUGHTON, Chairman and Managing Director of the Newmarket Gas Company, submitted "The Town and Trade of Boston," which was replied to by the MAYOR, who remarked that, as a trader, he always felt, when he received his accounts from the Gas Company, a certain amount of satisfaction, but with regard to their competitor he did not experience the same feeling. He assured the members that the town of Boston was very proud of their President.

The toast of "The Association" was entrusted to the Clerk to the Holland County Council, Mr. H. C. MARRIS, who assured those present that there was no more efficient service in the whole district than that offered by their excellent Gas Company. The Company were fortunate in having a progressive Chairman, and as a public official he greatly appreciated the kindness and courtesy which he received at all times from Mr. Chapman, as Manager. At this point the PRESIDENT intervened to express regret at the unavoidable absence of the Member for the Division, Mr. H. W. Butcher, who would otherwise have taken charge of this toast. He was very grateful to Mr. Marris for having stepped into the breach.

Get Closer Together.

On rising to respond, Mr. H. C. SMITH (President of The Institution of Gas Engineers) said the reply to this toast should really have been made by Mr. Chapman, and he must be taken as doing it as his deputy. This Association was a very important one, and was affiliated to the Institution, who appreciated the very valuable work done by the Association in the Eastern Counties. It was noteworthy in that for many years past it had welcomed to its ranks those on the side of the Industry which was responsible for the providing of plant and apparatus in connexion with the manufacture and distribution of gas. The Institution rather followed this lead about ten years ago by making it possible for those interested in the manufacture of plant, &c., to become members. This was a step in the right direction. There was no doubt that in the future they would have to get as close together as they possibly could. He was convinced that the various sides of the Industry were going to get much closer together in the future than they had done in the past, and in this good work he knew that the Eastern Counties Association would play a full part.

The final toast—that of "The Visitors and the Press"—was in the capable hands of Mr. THOMAS GLOVER, of Norwich, who must have joined the Association at about the time of the previous visit to Boston, and who has to his credit a lifetime of prominent service to the Industry. Remarking that those accepting the invitation to the luncheon included, besides the Mayor, a number of leading officials, Mr. Glover said that this might be taken as a sign of the happy relationship existing between the Boston Gas Company and the public authorities.

Annual Golf Competition.

During the proceedings, Alderman Kitwood presented the prizes which had been won on the previous evening at the Annual Golf Competition on the Boston Golf Club Course. The winners were:

Trophy and Cup Replica (presented by Mr. D. W. Turner)—Mr. M. H. Thornton.

Second Prize (presented by Messrs. Newton Chambers & Co.)—Mr. George Dixon (Nottingham).

Third Prize (presented by the Woodall-Duckham Company)—Mr. George Wright (Lincoln).

Fourth Prize—Mr. W. J. C. Garrard (Ipswich).

Well-Deserved Recognition.

There was also another particularly pleasing little ceremony, in the form of a presentation to Mr. Chapman.

Mr. C. R. FOWLER (Leiston) said the task he had to perform was a delightful one. As they were all aware, Mr. Chapman relinquished the duties of Hon. Secretary and Treasurer of the Association when he was elected to fill the

more important office of President. They knew how faithfully he had carried out his duties for six years, but only those who had served upon the Committee and had occupied the Presidential Chair could judge of the full extent of his care and attention to the work. Mr. Chapman had provided them with a striking example of the truth of the old adage that: "If you want a thing done well, you should get a busy man to do it." The members felt they would like to offer him some tangible token of their appreciation, and had decided upon a gold cigarette case, bearing the following inscription:

> "Presented to W. C. Chapman, Member of The Institution of Gas Engineers, by Members and Associates of the Eastern Counties Association, as a mark of esteem and in recognition of his services as Hon. Secretary and Treasurer from 1932 to 1938."

He had much pleasure, on behalf of the subscribers, in handing over the gift with their very best wishes. [Applause.]

The PRESIDENT expressed his great gratitude to Mr. Fowler for the kind things he had said, and to the subscribers for their handsome gift. They had made handsome recognition of services which had been freely given, and which had been to him a source of great pleasure.

Association Affairs.

At the business proceedings which followed, Mr. Chapman presided. Gratification was expressed by the President at the large attendance, the minutes of the last meeting were confirmed, and the new Hon. Secretary and Treasurer, Mr. H. H. Redwood (Newmarket) intimated the receipt of a number of apologies for absence.

The President's Medal was handed to Mr. Fowler, the Immediate Past-President, by the President, who remarked that the Association greatly valued the services rendered by that gentleman during his occupancy of the chair. They recalled with great pleasure the visit to Aldeburgh and Leiston in the spring of last year. Mr. Fowler said he would treasure the Medal as a memento of the very happy time he had spent as President of the Association.

Reference was made to the death of an associate member, Mr. Samuel Cutler, who was elected as long ago as 1902. A letter of condolence had been addressed to his widow, and the members stood as a mark of respect.

New Members.

On the proposition of Mr. H. R. WIMHURST (Bury St. Edmunds), seconded by Mr. R. E. WILES (Castletown), the following additions were made to the Membership Roll of the Association:

Members.—K. R. Mortimer (March), G. E. Shearman (Heckington), and J. Thorman (Huntingdon).

Associates.—K. de Beauvoir Carey (Cropston, Willey & Co.), F. H. Swain (London, Nautilus Fire Company), F. C. Wilson (Coventry, Geo. Wilson Gas Meters), Roy Kimber (London, Stanton Iron Works Company), H. G. Williamson (London, Director, Evered & Co.), G. H. Elliott (Gloucester, Newton Chambers & Co.), and R. M. Goodman (London, Director, W. J. Jenkins & Co.).

When the Committee's Annual Report and Statement of Accounts were presented, it was agreed that ten guineas should be voted to the Institution Benevolent Fund, as hitherto. Proposed by Mr. F. H. ROBINSON (Bishop's Stortford), it was further agreed that a sum of £25 be transferred from the general funds of the Association to their own Benevolent Fund.

The report and accounts were then adopted, on the motion of Mr. CLARKE (Stamford), seconded by Mr. L. BIRCHMORE (Louth).

Education Scheme Report.

The Eastern District Education Committee's Report was next presented by Mr. E. F. KEABLE (Gorleston), the Secretary to the scheme.

This stated that arrangements had again been made for examinations to be taken under The Institution of Gas Engineers through various centres. Gas-fitting classes had been well attended at the centres selected. Of 116 students, 20 were taking the Final Grade, having pursued their studies over the full period of five years. The Committee once more recorded their appreciation of the work done by the tutors of the classes, and their indebtedness to the Board of Education for the Short Courses for Teachers, to the gas undertakings which made the training possible and gave encouragement by the offer of prizes, and to the Education Authorities in the cities and towns concerned for their continued and valued co-operation. Thanks were also due to the Engineers of Cambridge, Colchester, Ipswich, Norwich, Luton, and Great Yarmouth for having furnished competent examiners for the Gas-Fitting Examinations.

The number of students taking the B.C.G.A. Domestic Salesmen's Course during the session under review was 13. One student from Chelmsford obtained a pass in "The Economics of Gas Supply," which entitled him to a Technical Commercial Certificate. The Committee expressed sincere thanks to the Engineers of those undertakings who permitted examinations to be taken on their premises and provided competent supervisors. They added: "This valuable course has now been brought up to date, and, in view of the ever-growing need for competent salesmen, it is hoped that every person thus engaged will feel the necessity for taking the course."

The adoption of the report was moved by Mr. G. WRIGHT (Lincoln), who voiced the sincere thanks of the Association to Mr. Keable for the admirable manner in which he carried out his duties in connexion with the scheme. Mr. W. W. TOWNSEND (Colchester) also expressed appreciation of Mr. Keable's outstanding services to the Association and to the students. He went on to say that he had been shown the papers set at the recent examinations in Gas Fitting, and he thought they were far too theoretical, and suggested a standard of attainment which it was unfair to expect of beginners in the gas trade. They were training men primarily to use their hands, and not to wrestle with abstruse problems, some of which were more suitable to examinations in Gas Manufacture than in Gas Fitting.

Mr. KEABLE said this point was quite appreciated by the Committee.

Mr. P. J. LUCAS, as Secretary of the British Commercial Gas Association, said he also would like to take the opportunity of thanking Mr. Keable for his valuable help.

The Presidential Address.

Mr. Chapman then delivered his Presidential Address, which is unavoidably held over owing to pressure on our space.

Mr. G. A. MALLETT (Ipswich) proposed a hearty vote of thanks to him. He said the whole theme of the Address was "progress," and they heartily congratulated the President on the success of his administration of the undertaking. The remarkable figures indicated the extent of his devotion to the interests of the Company. With regard to coke, he understood that the London and Counties Coke Association had now been able to extend their area from somewhere about that point across to Bristol, so as to embrace the whole of the counties south of a line drawn between these two points. Mr. R. Prince (Peterborough) seconded the vote, which was carried with applause.

Autumn Meeting.

Before the members adjourned for tea, some discussion took place regarding the arrangements for the autumn meeting; the alternatives being the acceptance of an invitation to visit the Corby Works of Messrs. Stewarts & Lloyds and a return to the programme of a meeting in London with a Paper. Ultimately it was left to the Committee to consider the matter further, with the understanding that they might endeavour to get someone to present a Paper in the autumn.

An Enjoyable Evening.

The members met again in the evening at the Assembly Rooms for the Annual Dinner, which was largely attended and graced by the presence of the Mayor and Mayoress and a number of other distinguished guests. The dinner was followed by a dance.

There were, of course, some speeches, and, to the gratification of all, the President (who was in the chair) was the recipient of further tangible proof of appreciation and goodwill. Mr. Nettleton, on behalf of the staff and all the employees of the Boston Gas Company, asked the President's acceptance of a case of pipes as a small token of their esteem. Mr. Chapman, in acknowledgment, said that he had greatly

valued the loyal help and co-operation of everyone in the service of the Company during the time he had been in Boston. Without this support it would have been utterly impossible for him to undertake the work he had.

The Boston Gas Company were cordially toasted on the proposal of Mr. C. R. FOWLER, who pointed to many proofs of the spirit of enterprise which governs the policy of the Company. He coupled with the toast the name of one "well-known and highly respected in the Industry." This was Mr. R. G. Shadbolt, a Director of the Boston Gas Company, with which he has been connected for the past forty years.

Mr. SHADBOLT said that, assuming 11 million consumers, a revenue for the Industry of £70 millions, and some 95% of the houses of the country using gas in one form or another, in proportion Boston had just about touched the figures which were the average of the whole country. Consequently, he called it a microcosm of the large and small undertakings of the country. In spite of the re-organization and reconstruction work they had seen that day, the Company had a dividend and interest bearing capital of only £50,000, for an output of some 180 million cu.ft. This was owing to the fact that it had been a continuous policy, and the administration of the Company had been particularly watchful over capital expenditure.

Proposing "Our Guests," Mr. W. W. TOWNSEND said they welcomed the presence at the dinner of the Chairman and Directors of the Gas Company, and felt it would be impossible to thank them sufficiently for the kindness and hospitality they were extending to the Association during their visit to the town. They also desired to thank those, including Mrs. Chapman, who had so well entertained the ladies.

The response was by the Town Clerk, Mr. C. L. HOFFROCK GRIFFITHS, who declared himself as being greatly impressed by the amazing vitality of the Gas Industry.

To Mr. P. D. WALMSLEY fell the pleasing task of submitting "The President," who, he remarked, was an outstanding example of what a gas engineer and manager should be. Mr. Chapman (who originally served his time with him) was with him at Yarmouth from 1919 for some years, when they practically rebuilt the works. They were strenuous times, and now he had had very much the same experience at Boston.

The toast was accompanied by musical honours, after which the PRESIDENT expressed his gratitude to Mr. Walmsley for the terms in which he had submitted it, and to the Chairman and Directors of the Company for the manner in which they had supported every suggestion put forward by him for the betterment of the undertaking. He also acknowledged the helpful co-operation of Corporation officials, without which no public utility official could properly do his duty to the town he was trying to serve. In Boston, Mr. L. Johnson efficiently combines the duties of Chief Constable and Toast Master, but it was in the latter capacity only that his services were requisitioned during the visit of the Association.

The Lincolnshire Wolds.

For the following day their hosts had planned further enjoyment for the visitors, and the weather being gloriously fine another memorable day resulted. In early morning coaches were ready to take the party first of all to the pumping plant at the new Fordington Works, which was inspected by permission of the Chairman, Mr. R. Salter, and members of the Boston Borough Council Water Committee. The drive was then resumed to the reservoirs at Revesby, where luncheon was served in the Red Lion Hotel. The tour was under the superintendence of Mr. T. H. Tyson, Water Engineer to the Borough Council, and passed through parts of the beautiful Wold country, where, as we have read, "high pasture lands are divided by deep valleys into almost isolated spurs of chalk hills, and steep roads are at times to be found." As Mr. Rushworth, writing in "Lovely Britain," says: "To the traveller from the south this is a revelation, an unthought-of possibility in a county which is so seemingly level in all its reaches." The tour was arranged to pass through the land of Tennysonian inspiration in the southern part of the Wolds, and after glancing at the house of his birth at Somersby, a halt was made at the nearby world-renowned "Brook." The country all around is of surpassing beauty, and those who had not passed that way before were literally thrilled. The expressions of thanks which followed the lunch were undoubtedly sincere.

Corrosion of Tar Stills

The Department of Scientific and Industrial Research has issued a report of an investigation, carried out at the Chemical Research Laboratory on behalf of the Association of Tar Distillers, into the causes and prevention of the corrosion of tar stills. (Chemistry Research Special Report No. 4, H.M. Stationery Office, 9d. net.)

The Report states that when tars were derived chiefly from the carbonization of coal in horizontal retorts, the 12-ton stills employed for the distillation of this material had an average life of 16,000 tons throughput and instances of 30,000 tons were not uncommon. Since the introduction of vertical retort tar, however, the life of such stills has diminished to an average of 7,000 to 8,000 tons when dealing with tars composed approximately of 75% vertical and 25% horizontal retort material. It was calculated that this reduction in the life of a still by 50% was equivalent to 5d. per ton of tar distilled and that the total cost of the tar distillation industry was of the order of £25,000 annually.

It was generally accepted that decomposition of ammonium salts present in the aqueous liquor normally associated with tar was responsible to some extent for the corrosion of stills, but it was also agreed that some organic constituent or group of constituents in vertical retort tars was mainly responsible for the damage. Accordingly, the objectives of the investigation were:

(i) To identify the compounds or groups of compounds responsible for corrosion;

(ii) to devise methods for the removal of such compounds or for the inhibition of their harmful action;

(iii) alternatively, to discover a metal or alloy which would resist attack or to develop a protective coating for the mild steel in general use as constructional material for tar stills.

To ensure that corrosion tests were carried out on primary constituents, the tars were first resolved into components by methods which precluded decomposition, based on the avoidance of high temperatures during distillation and on fractional precipitation by solvents. Selected fractions were then tested for corrosive properties, first on mild steel strips and secondly by distillation where possible from experimental stills constructed of identical materials.

After an exhaustive examination of a long series of tar fractions, the following conclusions were reached. The corrosive effect of neutral and basic constituents was negligible, but at high temperatures resinols or petroleum insoluble phenols were very active in promoting corrosion, and in the presence of ammonium chloride the activity of these materials was intensified. The more volatile phenols were not corrosive, a fact which is confirmed in industrial practice where tar acid stills have a very long life. Resinols are defined as those non-crystalline portions of tar soluble in caustic soda, and precipitated from solution in an organic solvent by addition of light petroleum. In a crude form they are isolated as a viscous pitch, but they can be purified to the condition of a brown amorphous powder. Low-temperature tars are particularly rich in resinols, whereas coke oven and horizontal retort tars are almost devoid of such components. Vertical retort tars occupy an intermediate position with respect to this content of resinols. Further examination of the whole range of resinols revealed the fact that the portion soluble in benzene was much more corrosive than the insouble part, probably owing to the circumstance that the latter, being highly polymerized, is almost inert. Confirmation of the conclusion that the corrosive effect of any tar is dependent chiefly on the content of benzene soluble resinols was obtained by comparative distillations of four tars.

The Report further states that the possibility of developing a technique whereby the resinoid portion of tar may be precipitated and only the oily fractions of the tar submitted to distillation was explored. A long series of distillations in experimental stills carried out on the petroleum extract of a corrosive tar established that the corrosion caused by this material is much less than that manifested by a so-called non-corrosive tar under comparable conditions of distillation.

Failing methods such as the foregoing process based on preliminary treatment of tars, a solution to the problem of corrosion of stills must be sought in the direction of finding a constructional material which will withstand the action of the corrosive constituents. A series of tests on selected metals and alloys indicated that nickel-chromium-molybdenum steels were quite unattacked by resinols alone and only slightly by resinols in presence of ammonium chloride. Nickel and nickel alloys were also very resistant.

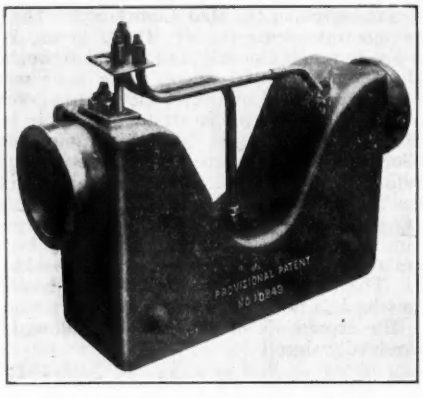
TRADE NOTES

The Butterley Isolator.

The anxiety shown by the Government to secure expansion of our armament indicates that the need is urgent. There can be no question that preparedness will prove a deciding factor and that the outcome of any conflict will depend very largely upon the efficiency of air raid precautions. Public services in particular must be protected, so as to minimize and localize trouble to small affected areas with as little disturbance as possible to other districts.

Gas distribution calls for special consideration. The control of affected areas by proper means of isolation is all-important, for leaking gas would threaten lives and property. Some form of isolator is required which will need the minimum of attention and maintenance, and this should be fitted in readiness for any emergency. Delay in such matters may prove of serious consequence.

It is with some interest, therefore, that we describe the Butterley patent isolating syphon (Patent No. 479650). This, besides



its obvious utility in localizing possible air raid damage, can be used for the ordinary purposes of a gas undertaking, combining the uses of the Horsley syphon with those of a controlling isolator. This safety syphon can be used for splitting-up distribution areas, closing trunk mains, safeguarding important buildings and works, linking-up with adjacent supply systems, and in the usual way in the laying, repairing, and testing of mains.

The Butterley isolating syphon has no moving or wearing parts, and there is therefore no necessity for a large manhole to give full access to all parts—the syphon needs only a small surface box, and there are no maintenance costs.

The syphon functions in three ways: 1. As a syphon functioning like the ordinary Horsley syphon; 2. As an isolator; 3. As a simple means of carrying out leakage and other tests.

The syphon provides a gas conduit of ample area and easy flow. Condensates and liquids are collected in the lower well and may be syphoned off as required. The capacity is larger than that of the standard Horsley type; if allowed to fill, the liquid will overflow into the mains without sealing the upper gas conduit.

By introducing water into the gas conduit by means of the sealing tube, the gas conduit weirs over into the lower well, which has the same seal with the water several inches below the level of the main. Only a few gallons of water are required. A syphon pump is used for unsealing. The syphon can be sealed and safely left.

Two ½-in. gas testing tubes are fitted to provide a simple means of carrying out leakage and other tests, and also to check readily that sufficient sealing water has been used and complete isolation effected.

The makers, The Butterley Company, Ltd., manufacture the Butterley isolating syphon in all standard sizes for general use. They have already supplied syphons up to 24 in. diameter, and are prepared to make syphons to meet any special requirements or conditions.

Herbert Morris, Ltd.

From Messrs. Herbert Morris, Ltd., Loughborough, we have received an attractive booklet giving details of the firm's lifting machinery, which includes stackers, portable jib cranes, elevating trucks, wall and sack hoists, slings, travelling trolleys, electric chain blocks, spur and worm-gear pulley blocks, and the "Morris" triple gear pulley-block, with which it is claimed any man can easily raise a weight of 1,000 lb. The firm have also produced an effective folder drawing attention to their boilers.

Copper Pipe-Line Services in Buildings.

A comprehensive practical handbook giving complete information on all matters relating to the design and installation of copper pipe-line services in buildings has been published by the Copper Development Association, Thames House, Millbank, S.W. 1, to whom we are indebted for the receipt of a copy. The book is handsomely bound, printed on art paper, and liberally illustrated with plate and diagram. Much of the information is of a strictly practical nature intended for those engaged in the actual installation of copper pipe-line services, while chapters are included for the assistance of those also concerned with the design and lay-out of such installations. A chapter is devoted to gas fitting, in which the advantages of copper for service pipes are set out, together with the necessary precautions to be observed when using copper under certain circumstances, such as when in contact with acid plasters and coke breeze partition walls. Tubes used in such situations, however, can easily be protected.

This publication should be of great interest to the distribution side. No charge is made for a copy, but it will be possible to obtain copies only when application is made on firm's headed notepaper, or, otherwise, when satisfactory evidence of responsible status or genuine interest is given.

Artistic Treatment of Gasholders.

Ever since the gasholder was invented it has been either a butt of humour or the subject of scathing criticism on the score of offence to the æsthetic eye. It was not until comparatively recent times, however, that undertakings seemed to become gasholder conscious so far as their appearance was concerned or make much effort to render them less conspicuous by the judicial application of paint, with a view to making the structures blend with their surroundings. Now that A.R.P. is looming large on the national horizon, undertakings will no doubt be the more anxious to camouflage so important a piece of plant in their own interests as well as those of the people who have the preservation of rural amenities at heart. It must not be assumed that the gasholder in the middle of a built-up area does not require similar attention, though the camouflage will necessarily be of a different nature. With the graded colours now available, however, it is not difficult to choose a suitable colour scheme wherever the works may be situated. Owing, too, to the large amount of paint needed for gasholders, it is sound economic policy to use a material which will last, as well as one which will not be affected by periodical immersion in the water tank or by acid atmospheres in industrial centres.

Such claims are made for their products by the makers of "Ferrodor" Metal Protection—a treatment which has been used

A Gasholder at East Grinstead painted with "Ferrodor" graded colours.

on metal structures in all parts of the world, in extremely exposed positions, and in many of the worst climatic and acidic conditions. "Ferrodor," which is manufactured by Messrs. Griffiths Bros. & Co., London, Ltd., is supplied in colours suitable for every type of surrounding, and, wherever the structure may be, it can be rendered inconspicuous from the air as well as made to harmonize with its surroundings when viewed from the ground. Care should be taken in the choice of colours used, and the firm's special representative is available at any time to consult with gas undertakings, while their technical staff and research chemists are prepared to assist in solving any painting problems without obligation.

THE ANNUAL MEETING OF
The South-Eastern Gas Corporation

The Sixth Ordinary General Meeting of the South-Eastern Gas Corporation, Ltd., was held on May 18 at the offices of the Corporation, 84, Horseferry Road, S.W. 1, Sir DAVID MILNE-WATSON, Bt., LL.D., D.L. (Chairman of the Corporation), presiding.

The GENERAL MANAGER AND SECRETARY (Mr. H. A. Probin, A.C.A.) read the notice convening the meeting and the report of the Auditors.

THE CHAIRMAN'S ADDRESS.

The CHAIRMAN said: The report and accounts have been circulated to the shareholders, and I assume that it is your wish that they should be taken as read. [Agreed.]

Since our last meeting the Corporation has obtained control of two more companies by acquiring nearly all the issued share capital of the North Middlesex Gas Company and of the Windsor Royal Gaslight Company. The North Middlesex Company supplies an area of 11 square miles in Hendon and Finchley, a good residential district where building development is taking place and may be expected in the future, while the Windsor area is a most useful addition from a geographical point of view as it means that we now have five companies to the West of London forming a compact group, and adjoining the area of our parent company, the Gas Light and Coke Company. The North Middlesex area also adjoins that of the Gas Light and Coke Company, and both of these acquisitions are, therefore, fully in accordance with the principle of grouping on a geographical basis, which we regard as essential if the fullest possible benefits are to be secured from holding company control.

Taking into account these additions, our associated companies supply nearly 300,000 consumers, and their annual output of gas exceeds 7,500 million cu.ft. It may interest you to know that if the figures are aggregated in this way there are only five gas undertakings in the country which are larger.

Increased Gas Sales.

The financial results of our companies have, of course, varied according to local circumstances, but, on the whole, we can be very well pleased with the results obtained during the year 1937, and it is satisfactory to record that, taking the gas sales of all our companies, an average increase of 2·8% was secured.

I would now like to call your attention to the principal changes in the balance-sheet as compared with last year. The issued share capital is increased by £813,626. In addition to the shares issued as the purchase consideration for investments acquired, 127,339 4½% redeemable preference shares and 100,000 4% irredeemable preference shares were issued for cash in April and August, 1937, respectively. The sum of £105,000 has been added to the capital reserve in respect of premiums on shares issued during the year, and from this has been deducted the expenses of acquisition and other capital expenses of a total amount of £65,000, the capital reserve now standing at the figure of £192,872.

There is one item which perhaps requires explanation, and that is the deficiency of £242 on the realization of holdings in the Lydd Gas Company. The gas output of this company when it was acquired by the Corporation was less than 2,000,000 cu.ft. per annum, and the company was then running at a loss. Further money was needed to carry out essential renewals, and the Corporation decided to purchase the undertaking and to provide financial assistance so that it would be possible for the supply of gas in Lydd to be continued. The company is now in the course of being wound up, and the gas undertaking has been transferred to the neighbouring New Romney Company, which is also under the control of the Corporation.

The only other figures on this side of the balance-sheet to which I would like to call your attention are the deposits and temporary loans and the loan from bankers, amounting in all to nearly £547,000. You will have seen from the Directors' report that we have issued £350 000 3¼% debenture stock since the close of the financial year, and the proceeds of this issue are being used to reduce our loans.

On the assets side of the balance-sheet you will see that our net acquisitions cost us £705,000, making the total book value of our investments in subsidiary companies nearly £5,000,000. Other investments have also increased, and we have about £40,000 more on loan to our subsidiary companies.

Revenue Account.

Coming now to the revenue account, we received £164,000 from dividends and interest, an increase of £40,000 on last year's figures. There were no increases in the rates of dividends paid by the subsidiary companies, the additional revenue being accounted for by dividends from the two new companies which we acquired, and by our receiving a full year's dividend for the first time on some of the investments acquired in the previous year.

Other income shows an increase of over £19,000. This figure includes the Directors' fees received from the subsidiary companies, and these were higher on account of the new companies acquired last year and in the course of the previous year. The growth of the Corporation also accounts for the increased revenue from other sources which is included under this heading.

On the debit side of the account directors' fees, which are fixed by the Articles of Association, amount to £9,200. General expenses are nearly £3,000 more on account of the additional work carried out at our London office, and we have had to provide over £3,000 more for income-tax.

After payment of preference dividends for the year at the usual rates, and an ordinary interim dividend in respect of the first half-year at the rate of 6% per annum, less tax, there remains a balance of £92,111 available for distribution. Out of this the directors are recommending the payment of a final dividend of 3%, less tax, making 6%, less tax, for the year, the rate paid each year since our incorporation. This will absorb the sum of £43,419, and leave £48,692 to be carried forward to the credit of the current year, compared with £28 613 brought in from last year. I think these figures show that we have again had a successful year. We actually earned more than 7% on the whole of the ordinary capital, and I am sure you will regard this as most satisfactory evidence of the strength of our position.

Increase in Costs.

Gas companies, in common, of course, with all industrial undertakings, have had to meet a serious increase in costs during the year. A further increase in wages has been granted to the employees of our companies as a result of national agreements with the trade unions, and there have been substantial increases in the cost of certain materials, and particularly in the price of coal. Very careful consideration was given by the board of each company to the possibility of meeting these extra costs out of existing revenue, but we were reluctantly forced to make small increases in the price of gas in eight of our 26 companies. The increases were kept to the lowest possible level, and the extra revenue derived from the increased price will in no case fully offset the increased costs.

It is common knowledge that many of the industries using coal on a large scale feel a lively dissatisfaction and an apprehension at the prospect of continued increases in coal prices, and the effect of these increases on their own production costs and budgets. While no one in these industries would grudge a fair reward to both capital and labour in the coal industry, there is reason to fear that the very proper concern which the community feels for the miners' welfare is being exploited to win public support for the maintenance of price levels unjustified by proper working costs, or indeed by anything except the power to charge such prices which the new selling schemes have conferred upon the coal industry.

Coal Prices.

But while this is a deeply felt grievance of all large coal users, there is reason for the gas and electricity industries to feel especially concerned not only on their own behalf, but on grounds of public policy. Increased coal prices for these two industries mean not only an addition to the cost of their main raw material, but also a serious handicap to them in that their raw material, coal, is also their principal direct competitor in the domestic and other fuel markets. It might be thought that this, while an additional grievance from their point of view, did not affect the public. But it must be remembered that gas and electricity, as smokeless fuels, have more than a commercial claim for fair play. It is a point of serious public concern that the lessening of the smoke menace which costs this country so dear in health, in money, and in amenity should not be slowed down or interrupted because the smoke-producing fuel has the power to hold to ransom the two great industries whose business it is to take raw coal and turn it into cleaner and more efficient forms of heat and energy.

Increased attention to the gravity of the smoke problem and

more urgent and determined measures to cope with it are bound to come in the near future, and I think the Government, local authorities, and the public generally should realize how serious an obstacle to the progress of this good cause is contained in the unreasonable competitive advantage which the raw coal industry wins for itself by imposing high prices on its competitors.

The legislation to which I have referred tends to place both gas and electricity at a disadvantage in competing with solid fuel, but a number of gas companies in Kent are suffering a particular disadvantage which affects gas only and does not touch competing fuels of any kind. Certain towns in Kent still continue to charge a special due on all coal entering the town. Those dues were originally imposed under Acts passed more than a hundred years ago, and although the incidence of them has entirely changed it has not been possible to secure any relief. A particular case where this bears hardly upon us is at Dover. All seaborne coal used in Dover has to pay a due of 1s. 7d. per ton, and the cost of all gas manufactured at our Dover works is increased correspondingly. Nearly half the gas produced there is supplied to districts in East Kent outside the Borough of Dover, and the fuels with which our gas competes in this area do not have to pay the due. We are considering closely whether any action can be taken to remedy this anomalous position.

Advantages of Grouping.

We have now had some years' experience of the grouping of gas companies under a holding company, and we have found it possible to secure a large number of the economies and advantages of amalgamations without the expense and delay which is necessary to bring these about. Some of the advantages, for instance, which we have secured are the purchase of stores in bulk, co-operation in sales policy, and the possibility of planning extensions of works and mains with a view to future developments. Our present system of control whereby the companies which we take over retain their individuality has distinct advantages in the way of flexibility and the power to meet local needs, but we feel that some reduction in the number of administrative units, which is at present 26, would be of undoubted benefit.

The McGowan Report on the distribution of electricity emphasized the fact that there are at present too many separate electricity undertakings, and that larger units must be formed if the maximum degree of efficiency and economy is to be attained, and there is no doubt that the same applies to the Gas Industry. The fact that a majority of the equity capital is under one control greatly facilitates amalgamation, and the acquisition of a group of companies by a holding company is an important step towards the eventual formation of gas supply areas of a size and composition which are economic under modern conditions.

Sales of Appliances.

I would now like to tell you something of the various activities of our companies, and first of all with regard to the sales of appliances. Our companies have again joined in the group campaigns for the marketing of gas fires, water heaters, and refrigerators which have been organized by the majority of the companies in London and the South-East of England. We have found the publicity of these campaigns most helpful, and we shall continue to co-operate in them. It has been found of advantage in these campaigns for the same terms to be offered by all companies for the particular appliances which are advertised, and we have been able to carry out an important extension of this principle in the case of the five companies to the west of London, all of which are now offering appliances on the same terms as the Gas Light and Coke Company. We have no doubt that the uniformity of conditions of sale which has thus been secured over an area of more than 900 square miles will be appreciated by our customers.

One of the most encouraging features of the past year has been the excellent way in which the sales of all appliances have been maintained, a number of companies having reached record figures.

Showrooms.

I have referred to the assistance obtained from the London Group advertising scheme, but in order to obtain the fullest benefit from publicity it is essential that the companies should have properly equipped and well-situated showrooms with an efficient local sales organization. As an example of the improvement which can be secured by attention to these matters I might mention the Lewes Gas Company. This company had no proper showroom before the Corporation obtained control, and last year a showroom was opened in a prominent position in the High Street, while at the same time a thorough reorganization of the distribution and sales side of the undertaking was carried out. As a result of this the value of the appliances sold during the first four months after the opening of the showroom was 250% above the value of the sales for the corresponding period of the previous year. We are proceeding rapidly with our policy of improving existing showrooms and securing new sites where necessary. Showrooms are in course of construction on new sites in the Folkestone, Chertsey, and Sittingbourne areas, while new showrooms and offices are to be constructed for the Uxbridge Company on their existing site in the High Street, Uxbridge.

I have just given you a brief account of the steps we are taking to increase the sales of appliances, but what, of course, is even more important to us is to increase the use of gas by our customers. In many cases, as you probably know, the selling of appliances does not bring increased consumption, as a large number of them replace old appliances which were much less efficient. Our principal aim must be to encourage our customers to make the fullest possible use of gas, and suitable tariffs are of the greatest assistance in this direction. We are constantly giving attention to this, and we have already introduced a number of promotional tariffs, and more will be introduced as soon as possible, so that gas may be obtained for all purposes at reasonable rates.

Public Lighting.

We have again been successful in obtaining a number of public lighting contracts, the period of the contract being in some cases as much as 15 years. As you may know, the Ministry of Transport has recently issued a Report by a Departmental Committee on Street Lighting, and the standard of lighting recommended for main roads is above that of many existing installations. In the last few years great improvements have been made to gas street lighting equipment, and we are taking every opportunity to show local authorities that their needs can be met by gas by submitting schemes for improved lighting and erecting demonstration lamps.

I should now like to deal with the technical side of our activities. One of the great advantages of having a number of neighbouring companies under one control is that it is possible to decide upon a long-term plan of production and distribution, and to work towards this when extensions of plant and mains are made in place of considering each scheme with reference to the needs of one company alone. Economies can for instance, frequently be effected by the giving of a total or partial bulk supply from a large works to a small neighbouring company. We have arranged for the existing works of the Sittingbourne Company to be closed down and for a bulk supply to be taken from the Rochester, Chatham, and Gillingham Gas Company, and consideration is being given to the possibility of other such supplies.

Additions to Plant.

Attention is also being given to the improvements which can be effected at each of our companies' existing works. Benzole plants have recently been installed at a number of them, and the total output of benzole for the past year was 75% above the output for the preceding year. Benzole plants have been ordered for three more works, and the economies of installing them at other works are under consideration. The extraction of benzole from coal, even in comparatively small quantities, helps to reduce our need for imports of oil, as it is one of the few sources of home-produced motor fuel. At the same time it forms a valuable addition to the revenue of gas companies.

We have been able from time to time to make savings on the insurances of our associated companies, and a further instance occurred this year, when it was decided to arrange for an insurance company to carry out the inspection of gasholders required under the Factories Act, 1937. The gasholders of all our companies were grouped together, and a substantial reduction in premium obtained by this means.

Work at Central Office.

I have already said that an increased amount of administrative work is now being undertaken at our London office. While on the sales side it is essential for there to be an organization in close touch with local conditions, we have found that a large part of the secretarial and accountancy work which was formerly carried out at the office of each company can be efficiently and economically done in London. We have accordingly adopted a policy of transferring such work to our central office whenever circumstances permit. This policy has an additional advantage in that it enables the directors to be kept in much closer touch with the affairs of the individual companies. In a number of cases also the work at the local offices of the companies has been reorganized and improvements made, such as the introduction of continuous meter reading, and the use of accounting machinery, enabling accounts to be rendered to consumers more promptly, and decreasing the amount of overtime and extra assistance formerly necessary at certain periods of the year.

I mentioned in my speech last year that we were intending to introduce a comprehensive life assurance and pension scheme for all our companies, and this was brought into operation on June 1,

1937. The scheme provides a pension on retirement at 65, with a life assurance benefit equal to an employee's annual wage or salary in the event of his death while in our service. A number of our associated companies had pension funds in operation before, and these will be continued for the benefit of their existing members, all future employees coming into the new scheme. In some cases no definite pension scheme was in operation, and the introduction of the new scheme has been very generally welcomed.

The CHAIRMAN concluded by moving the adoption of the report and accounts.

Mr. HENRY WOODALL, M.Inst.C.E., seconded the resolution, and it was carried unanimously.

The dividend was approved; the retiring Directors, Mr. R. W. Foot and Mr. T. Hardie, were re-elected; the Auditors, Messrs. Cash, Stone, & Co., were re-appointed, and the proceedings terminated with a vote of thanks to the Chairman, Directors, and staff.

The Sheffield Gas Bill

Consideration of the Sheffield Gas Company's Bill was commenced on Monday, May 16, by the Committee of the House of Lords which dealt during the previous week with the West Yorkshire Gas Distribution Bill. The Committee comprises Lord Cozens-Hardy (Chairman), Lord Muirhead, Lord Abinger, Lord Banbury of Southam, and Lord Ebury.

The main proposal of the Bill, and the one which gave rise to most opposition, is to add a large area to that in which the Company has power to purchase coke-oven gas, the proposed new area including the County Borough of Doncaster and various urban and rural areas in the West Riding of Yorkshire, and in Derbyshire and Nottinghamshire, including the boroughs of East Retford and Worksop. Another proposal, which gave rise to some opposition, is to add the parish of Orgreave, in the rural district of Rotherham, to the Company's ordinary limits of supply, to which it is now contiguous.

Sir Walter Monckton, K.C., Mr. Sidney Turner, K.C., and Mr. Maurice Fitzgerald, K.C., represented the Company.

The petitioners were the United Steel Companies (represented by Sir William Jowett, K.C., Mr. Jacques Abady, K.C., and Mr. H. Willis); Messrs. Barber, Walker, & Co., Ltd., and others (Mr. W. Craig Henderson, K.C., and Mr. H. Willis); Rotherham Corporation (Mr. A. M. Trustram Eve, K.C., and Mr. E. J. C. Neep); Chesterfield Corporation (Mr. Neep); Notts County Council (Mr. Tristram Beresford, K.C.); Worksop Corporation (Mr. Tristram Beresford, K.C.); and the Derbyshire Miners' Association (Mr. H. Willis).

The Derbyshire County Council; Doncaster Corporation; South Yorkshire and Derbyshire Gas Company; Swinton and Mexborough Gas Board; West Riding County Council; and Wombwell U.D.C. also petitioned, but were not represented by Counsel.

Sir WALTER MONCKTON, opening the case for the Company, said that two proposals of the Bill which were not the subjects of opposition were to change the name of the Sheffield Gas Company to "The Sheffield and District Gas Company," in view of the fact that the Company had gradually extended its sphere of operation, and to consolidate and simplify the existing provisions of the Company's Acts and Orders relating to its depreciation fund.

Dealing with the proposed extension of the area in which the Company may purchase coke-oven gas, he said the area proposed to be added was a coalfield area in which coke ovens were likely to be erected as further demands for their products arose. In that area the Company sought merely the right to negotiate for the surplus coke oven gas beyond that which the gas undertakers in that area might require from coking plants within their own limits of supply; the Sheffield Company did not seek powers to acquire supplies of coke oven gas compulsorily.

The reasons which had driven the Company to ask for the extension of its coke oven gas limits were that the cheap gas which industry ought to have available could be made available by using coke oven gas, and that such coke oven gas as was produced ought not to be wasted.

Constitution of Sheffield Board.

The total area of the ordinary limits of supply of the Sheffield Company was 313 square miles, and more than 1,000 miles of mains had been laid there. The Company was governed by a Board of Directors of whom seven were appointed by the shareholders and three were nominated by the Sheffield Corporation; the Corporation had power also to appoint an auditor. The Company operated under the basic price system, the basic price in the Sheffield area being 7d. per therm (there being a higher basic price applying to areas where differential charges were authorized), and the basic dividend was 5%. The price charged to consumers for domestic purposes in Sheffield was 6·8d. per therm (2s. 10d. per 1,000 cu.ft.), which was very moderate; the price charged for large quantities used for industrial purposes, in respect of which the Company had been very largely pioneers, was 2·37d. per therm (11¼d. per 1,000 cu.ft.). In other parts of the area of supply the charges were higher to the extent of the authorized differentials.

In Orgreave, which it was proposed to include within the Company's ordinary limits of supply, there was no gas undertaking, but the Company did in fact supply a certain amount of gas in part of that area. The United Steel Companies did not oppose the Gas Company's request for power to supply there. But they owned works, and some buildings and other property, in the parish, and did not wish to be restricted from supplying coke oven gas there to industrialists other than their own subsidiaries; they would have power to supply it only to their own subsidiaries. That restriction applied to producers of coke oven gas throughout the ordinary limits of the Gas Company, and with the inclusion of Orgreave within its ordinary limits of supply, the Company would desire that the restriction should apply there also.

The Gas Company's 1931 Act extended its ordinary limits of supply and its coke oven gas limits. Within the ordinary limits of supply, its powers to supply coke oven gas were not restricted. Outside the ordinary limits of supply, but inside the coke oven limits, it was restricted to giving bulk supplies to gas undertakers in their respective areas and, with the consent of those undertakers, to other users in their respective areas. There was an obligation to supply coke oven gas to the various gas undertakers, with the proviso that the Company could not be called upon to give to any one of those gas undertakers a greater quantity that it could obtain from coke oven plant within that undertaker's area of supply. There was an obligation to give certain supplies to the Rotherham Corporation, unless otherwise agreed.

A point that was made against the Bill was that possibly it would prevent other undertakers securing supplies which otherwise would be available to them. But he emphasized that the right which the Company sought to collect coke oven gas outside its ordinary limits of supply was merely the right to collect the surplus beyond the requirements of other undertakers in the areas in which it was produced, and it was limited to purchase by negotiation, and not by compulsory acquisition. There was also a series of obligations to give supplies to protected persons.

Looking for Further Resources.

The Company was taking in substance the whole of the surplus coke oven gas within its existing coke oven gas limits, and the increase of consumption was such that it was time it began to look for further resources with which to supplement those already available. In 1937 the amount available to the Company from the coke ovens was 31¼ million cu.ft. per day, and the Company had taken the whole of that. It was anticipated that a further 2 million cu.ft. per day might be made available in the course of 1938, which would bring the total available to 33¼ millions per day; but that would not be sufficient to enable the Company to dispense with manufacturing gas in the winter months. Inasmuch as manufacture at the gas-works involved considerably greater costs than the purchase and supply of coke oven gas, it became more difficult in those circumstances to compete with other fuels. During the three months ended March, 1938, the average daily output in the Sheffield area, apart from week-ends, was about 37 million cu.ft. per day; the highest daily output reached was about 39 millions. Further, there was a constant substantial increase of the demands made upon the Company. It was essential that the Company should be in a position to satisfy potential consumers that they would with certainty be supplied with the gas they required; they wanted that assurance before

they could change their plant to enable it to use gas and before they would place long-term orders for quantities. Therefore, in order to stimulate development, the Company must secure its resources in advance. It asked for powers in a further coalfield area in which it could hope to acquire further supplies of coke oven gas.

The amounts of gas sold by the Company for domestic and industrial purposes, and including bulk supplies, were 6,886 millions in 1935, 8,280 millions in 1936, and 9.887 millions in 1937. The innovation of the coke-oven gas network in South Yorkshire, which had the blessing of the Area Gas Supply Committee of 1930, had been proved, and the Company now asked for the natural and logical extension of the coke oven gas limits.

There seemed to be a suggestion on the part of petitioners that a careful investigation of the manner in which the Company had used its coke oven powers was called for. In that connexion he pointed out that in 1934—three years after the coke oven gas powers were given to the Company—the matter was fully debated before Committees of both Houses of Parliament, and the result was the Company's 1934 Act.

Whereas, on the one hand, it was suggested by petitioners that the extension of the coke oven gas limits would result in the Company competing with others who wanted to purchase coke oven gas and would artificially raise the price, on the other hand it was said that the effect would be to cut the price. Those two arguments seemed to cancel each other out. It was vital that there should not be waste, and it would be retrograde to suggest that the Sheffield Company should not have gas that was available, even though other undertakers did not want it.

The Nottinghamshire County Council, in its petition, objected to the extension of the coke oven gas limits to include a portion of the county, and suggested that there was no necessity or demand therefor. The Bill was referred to as an attempt to stake out a claim; it was urged that there was only one colliery in the Notts portion of the area producing coke oven gas, that it would not be an appropriate means of dealing with the matter to run a long main to one colliery, and that even if additional coke ovens were constructed in the area, the effect of the proposals in the Bill would be detrimental to gas undertakers in the county, for it would create unnecessary middle-men.

Counsel commented that, even if coke oven gas were not available in the area at the moment, it could not be assumed that there would be none there in the future. It was largely a coalfield area, and when there was an outlet for the products of coke ovens it was quite likely that they would be provided. Obviously the Company would not endeavour to secure a supply of coke oven gas in circumstances which were unsuitable and uneconomic. The extension of the Company's coke oven gas limits would not be detrimental to the gas undertakers in Nottinghamshire: the Company would not be able to take any gas which was not surplus to their requirements. It would be a pity if the good work which the Company had done should not be allowed to continue merely because it was a Company; and in that connexion he emphasized that the Sheffield Corporation had three Directors on the Board, who could be trusted to look after the public interests.

In the petition of the Worksop Corporation it was pointed out that there were several large collieries within the Borough area, that several collieries were likely to open in the surrounding area, and it was feared that the Sheffield Gas Company would monopolize supplies of coke oven gas by reason of its size; it might result in an increase of the price of gas to consumers within the Borough. Sir Walter said that the Worksop Gas Company was not represented before the Committee by Counsel; but that Company had contracted for a supply of coke oven gas from Messrs. Barber, Walker, & Co., who were petitioners, and who were outside the Worksop Company's area of supply, and apparently feared that the price of coke oven gas would be reduced. The Sheffield Company was not asking for preferential tariffs, however, but merely for power to negotiate for supplies.

The Chesterfield Corporation pointed out that it was empowered to contract for supplies of gas in bulk and for supplies of coke oven gas for use for the purposes of its gas undertaking, and that it had entered into contracts for supplies of coke oven gas from two companies over a period of years. It was said that one of those companies was within the Corporation's area of supply; the other was outside that area of supply, but within the coke oven gas limits of the Sheffield Company as proposed by the Bill. There were other companies to which the Corporation would be entitled to look in the future for supplies under present conditions; apart from the fact that the finances of the Sheffield Company were very great, it would be unfair to place the Company in a position to secure gas from those sources, for in that event the Corporation would be able to purchase such gas only after it had passed into the South Yorkshire grid. It was also urged that there was no reason for extending the Company's coke oven gas powers further into the county of Derbyshire than they extended at present.

Sir Walter Monckton commented that the coke oven gas powers of the Company already extended a considerable distance into the county. With regard to the companies with which Chesterfield had contracted for supplies of coke oven gas, he said that the company which was referred to as outside the Chesterfield gas limits was not in fact within the extended coke oven limits proposed by the Sheffield Gas Company.

Mr. E. J. C. NEEP (for the Chesterfield Corporation) said his two points were an objection to the Sheffield Company taking in the urban district of Staveley, in which was situated the undertaking of the Staveley Iron and Coal Company, and an objection to a proposal in the Bill—which probably had been overlooked—to take away a portion of the Corporation's existing gas limits.

Sir WALTER MONCKTON, dealing with the petition of the Rotherham Corporation, in which it was stated that the Bill would make it difficult, or even impossible, for the Corporation to purchase coke oven gas within its limits of supply, except from the Sheffield Company, said that in the Company's 1931 Act there was a responsibility upon the Company to make available to Rotherham certain minimum quantities from two particular suppliers of coke oven gas, so long as the Company could obtain supplies from those two suppliers, and the price to be paid to the Company by Rotherham was to be ½d. per 1,000 cu.ft. in excess of the grid price, which latter was the price paid by the Sheffield Company. The position at the moment, he said, was that Rotherham was not taking from the grid all that it had the right to demand; if that were so, it seemed a little odd that Rotherham should seek to prevent the Company from taking further supplies from the area, which supplies it already needed.

The petition of Messrs. Barber, Walker, & Co. and other owners of coke oven plants in the area proposed to be added to the Sheffield Company's gas oven gas limits urged that the Bill would place the Sheffield Company in a privileged position, and that it would be able to take coke oven gas from the West Riding of Yorkshire and sell it in the Derby and Notts area, where customers were already conveniently supplied from the petitioners' coke ovens; therefore, the petitioners would incur serious loss. Counsel's comment was that the Sheffield Company wanted to purchase coke oven gas in that area, by agreement with the producers, and that surely it was not a great hardship to those producers that their markets should be increased by the advent of another possible purchaser! It was quite wrong to suppose that the object of the Bill was to find for the Sheffield Company an outlet for coke oven gas for which it would not find a market in its existing limits.

The petition of the Derbyshire Miners' Association pointed out that the wages of its members depended on the price of coal, that the price of coal depended to a large extent on the value of by-products, and that the Bill would restrict the possibilities of the profitable sale of coke oven gas by the proprietors of the coke ovens. Counsel reiterated that the presence of the Sheffield Gas Company as potential purchasers would improve the chance of absorbing the coke oven gas produced.

Another objection by petitioners was that the Bill would have the effect of retarding, if it did not render impossible, the provision of a suitable network of mains for the collection and distribution of coke oven gas in the Derbyshire coalfield.

The Evidence.

Lieut.-Colonel Sir *Henry K. Stephenson,* Bart., D.S.O. (Chairman of the Sheffield Gas Company), gave evidence in support of the Bill. The Sheffield Gas Undertaking, he said, was the second largest in the provinces, so far as the output of gas was concerned. In addition to making cheap gas available for industry, the Company had carried out a great deal of research whereby the applications of gas to industry had been extended; it had been able to construct furnaces which represented improvements on those available previously, and, as a result, to increase the sales of gas.

It was the opinion of the Board that the demand for cheap industrial gas would be permanent; and the available surplus from coking plants in the Company's existing coke oven gas limits was inadequate to meet the demands made upon the Company.

Mr. A. M. TRUSTRAM EVE, cross-examining, said that the Sheffield Company first secured powers for coke oven gas supplies by its Act of 1917; Rotherham secured exactly similar powers in 1918, and between that year and 1931 there was a small overlap of the coke oven gas limits of the two undertakings. In 1931, the Sheffield Company obtained an extension of its coke oven gas limits, subject to certain limitations, and since that time there had been an overlap of substantially the whole of the Rotherham limits; so that, in theory at any rate, the Company and the Corporation had equal rights for the purchase of coke oven gas within the Rotherham limits. If the present Bill were passed, the Rotherham coke oven gas limits would be completely surrounded by the Company's limits, and he asked if the two undertakings could still compete without difficulty in the same area.

Witness said he did not think there had been difficulty in the past.

COUNSEL quoted from a report of a speech by Sir Henry to shareholders to the effect that if Parliament granted the powers sought by the West Yorkshire Gas Distribution Bill (which was

before the same Committee of the House of Lords a week previously), the Sheffield Gas Company would be unable to obtain additional supplies of coke oven gas beyond those available within its present coke oven gas limits, and that further expansion by the Company would be made almost, if not quite, impossible. Counsel pointed out that if the Bill, in its original form, had become law, the areas in which the West Yorkshire Gas Distribution Company and the Sheffield Company would have had powers to purchase coke oven gas would have overlapped. But the West Yorkshire Bill was amended. He suggested that the Sheffield Company would not have been in Parliament this session but for the West Yorkshire Bill.

Witness replied that the Sheffield Company might have come next session.

COUNSEL said that the Sheffield Company was taking huge quantities of coke oven gas from the Rotherham area. He urged that if the local undertaking wished to use the local coke oven gas, it should have the prior right to use it, and that when it did not require that gas the Sheffield Company could use it.

Witness replied that the local undertaking had the right.

COUNSEL asked how the Rotherham Corporation was to obtain further supplies of coke-oven gas if its area were completely surrounded by the coke oven gas limits of the Sheffield Company.

Witness said he did not think Rotherham could say what would be the position there a year or two ahead.

COUNSEL commented that the Sheffield Company was envisaging the position a few years ahead. He pointed out that in the enormous area which the Company sought to add to its coke oven gas limits there were only two coke oven plants existing at the moment, and the Company hoped that, having staked its claim, the coke oven gas would be available there some day.

Mr. TRISTRAM BERESFORD said that the only coke ovens in the part of Nottinghamshire which was included in the Company's proposed new area were at the Harworth colliery, and by agreement with the Colliery Company a supply of gas could have been obtained, without the necessity for promoting the Bill. He also pointed out that, although it was said that the Sheffield Company was getting towards the end of the supplies of coke oven gas available in its existing limits, apparently the Company was prepared to supply to Doncaster Corporation 750 million cu.ft. per annum, the agreement for which had been discussed, though not yet actually executed.

Witness replied that that matter had been under discussion since 1932, and it would not become operative for more than a year.

Mr. NEEP said that the works of the Staveley Iron and Coal Company, which were included within the proposed new coke oven gas limits of the Sheffield Company, were just outside the present Chesterfield gas limits, and Chesterfield would naturally look to those works in the future for extra supplies of gas.

Witness replied that gas was not available there at the moment, and he did not think the possible supplies there should be reserved.

Mr. WILLIS said that the Sheffield Company had made agreements, extending over a period of years, to take supplies of coke oven gas from various coke oven plants in South Yorkshire. If the demands for gas by existing customers of the Sheffield Company were to fall seriously, the Company might have difficulty in disposing of the supplies. It could then offer the gas—probably at almost any price, in order to avoid wasting it—within the new limits, for the Company would have power to offer it to consumers, with the consent of the local gas undertakers, and, if there were no local gas undertakers, the Company would be able to offer it without anybody's consent.

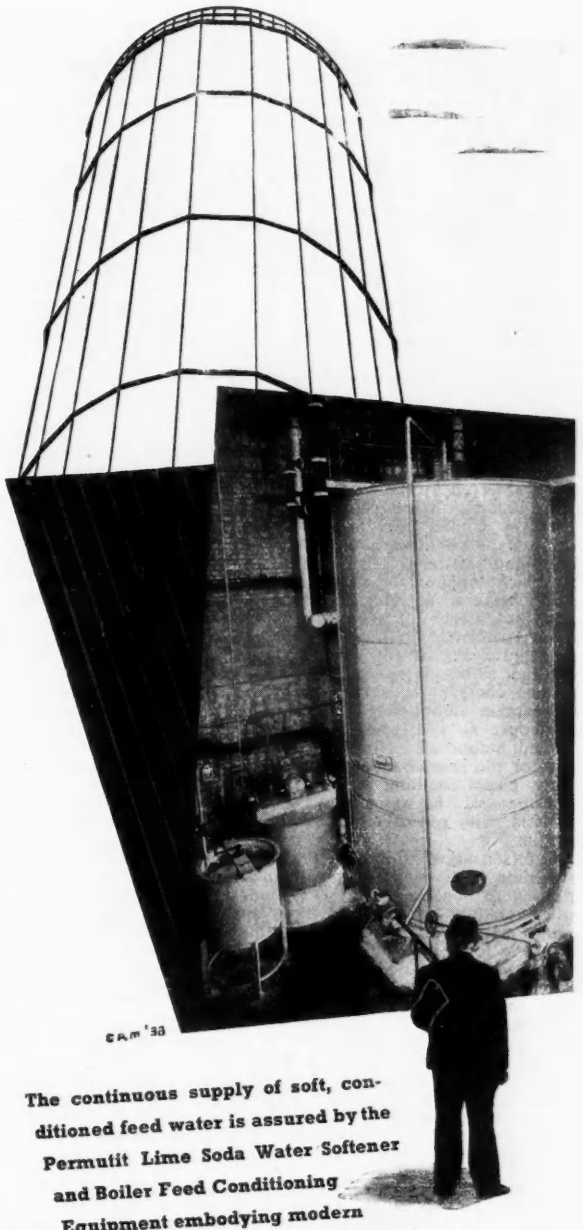
Witness said that that was not the intention, but he was not prepared to give a direct answer to the question without further consideration.

Tuesday, May 17.

On Tuesday morning Sir Henry Stephenson was cross-examined by Sir William Jowett, K.C., on behalf of the United Steel Companies, which have a capital of £10,000,000, and own steel works, blast furnaces, coke ovens, &c. Sir William said that the United Steel Companies produced over 13% of the entire steel production of this country. Discussing the parish of Orgreave, situated about 5½ miles east of Sheffield, he said that apart from a few dwelling houses and farm buildings, it contained practically only the Orgreave colliery and coke ovens. A considerable portion of Orgreave was land belonging to United Steel, and it might be developed in the future. A possible development was hydrogenation of coal on that land, although there was nothing like a project at the present time.

The supply of gas to the population of Orgreave, which numbered 102, suggested Counsel, was trivial. The effect of adding Orgreave to the Sheffield Company's statutory area of supply would add nothing to the powers of the Company, which was already supplying there.

Witness replied that it would give the Company powers to



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break up streets, and the ordinary powers of statutory undertakers.

COUNSEL said that United Steel had no objection whatever to the Company supplying gas for domestic purposes in Orgreave. Obviously the purpose of the proposal was not to enable the Company to supply there, but to impose restrictions upon United Steel against the supply of gas to any enterprise in Orgreave in the future.

Witness replied that the Company did not seek to impose any more restrictions on United Steel than upon anybody else; it sought to impose only the restrictions which were imposed on everybody else in the Company's area.

Reverting to the position in 1931, Counsel said that both the Sheffield Gas Company and the coal owners had contemplated starting a gas grid in South Yorkshire and competing Bills were deposited in Parliament. Under the auspices of the Board of Trade, an agreement was hammered out between the parties, as the result of which the Bill deposited by the coal owners was withdrawn, the Sheffield Company's Bill was amended, the coal owners lent their support to get the Sheffield Bill through, and Parliament accepted the agreement. As a result the Sheffield Company had secured its coke oven gas limits and had got rid of what might have been a very troublesome opposition. Then in 1934 the Company came back to Parliament, the burden of its song being that, although the letter of the agreement was being observed by the owners of coke ovens, the spirit of it was being broken. It was complained that a supply was being given direct by United Steel to the Tinsley Wire Company's works, which were within the area of supply of the Sheffield Gas Company, and yet the grid had been constructed at great expense to give such supplies. Rightly taking its stand on the sanctity of the agreement, the Sheffield Company had asked Parliament to stop that breach of the spirit of the agreement. But it had asked Parliament to impose further restrictions within its area of supply. Parliament had decided that pre-existing contracts were not to be affected, and that nothing was to affect the supply by one company to a subsidiary in Sheffield; and the part of the bargain authorizing the sellers or their constituent members to supply as and when they liked outside Sheffield had remained untouched. Now, he said, the Sheffield Gas Company was for the second time asking Parliament to smooth away the rough places resulting from the agreement.

Witness said he was asking Parliament to confirm the decision of 1934, with regard to an addition to the Company's area of supply.

COUNSEL asked if it were the Company's proposition that, in extending its limits of supply to include Orgreave, it should be allowed to impose further restrictions upon United Steel.

Witness said that the restrictions applied throughout the Company's area of supply. The Company would have asked to add Orgreave to its area of supply in any case, for at the moment it was a no-man's land from the point of view of statutory gas supply. The existence of the works of United Steel there was mere coincidence.

COUNSEL put the hypothetical case that a factory might be erected on land of United Steel in Orgreave, and close to the United Steel coke ovens, by a company which was not a subsidiary of United Steel. If the Bill passed, the United Steel would not be able to supply coke oven gas to that factory without the consent of the Sheffield Company. He asked how that would square with the agreement made in 1931, as the result of which the coke oven owners had withdrawn opposition to the Sheffield Bill of that year.

Witness replied that the gas supplied by the Sheffield Gas Company had to bear its portion of the interest on the capital cost of the grid. If United Steel were allowed to supply a factory direct through a main only a few hundred yards long, the owners of that factory would be able to under-sell their competitors, whose factories were in Sheffield, and that would introduce very unfair competition with other manufacturers.

COUNSEL said that, by extending its limits of supply to include Orgreave, and placing further restrictions on United Steel, the Company was altering the 1931 contract to the disadvantage of United Steel.

Witness disagreed.

COUNSEL asked if witness were content that the position should remain as expressed in the agreement in 1931, with the emendations introduced by Parliament in 1934, which was that the coke oven owners had no right to supply within the limits of the Sheffield Company as they existed at that date, except to subsidiary companies or under pre-existing contracts.

Witness said the Company was not asking for anything more than that Orgreave should be included in the Company's area of supply under the conditions existing in 1934.

In reply to further suggestions that the Company sought to increase restrictions on United Steel, which happened to be the only firm in Orgreave, Sir Henry said that obviously the Company could not be respecters of persons in these matters.

Re-examined, he agreed that the Sheffield Company paid a fixed price to the Grid Company for coke oven gas, and if United Steel were to be at liberty to bargain with a nearby consumer, it could be assumed that they could charge a lower price than the grid price. That would cut across the whole principle of the grid. The extension of the Sheffield Company's ordinary supply area to include Orgreave was a normal extension, and it was convenient to place Orgreave in the same position as the surrounding area.

Mr. *Ralph Halkett* (General Manager and Secretary of the Sheffield Gas Company) was the next witness. He said that the Company made gas at three works. Dealing with a suggestion that storage capacity might reasonably be increased, he said that a new 8,000,000 cu.ft. gasholder had been constructed recently, and the Company had gone as far as it ought to go, from the economic point of view, in respect of storage capacity. New purification plant had been installed at the works at Wincobank, some of it being used for purifying coke oven gas.

The Company's area included the City of Sheffield, parts of the County Boroughs of Rotherham and Barnsley, and areas in the West Riding of Yorkshire, and in Derbyshire. Its existing interests in Derbyshire concerned 162 square miles, comprising the southern part of the Company's area of supply. The total share and loan capital issued was £2,981,566, and the capital expenditure to the end of last year was £2,290,000.

A former agreement (commenced in 1921) with United Steel for the supply of coke oven gas expired in 1932, and the Company was unable to renew the contract at a price it could afford to pay. It was taking at the moment an accommodation supply from the United Steel at an agreed price; that arrangement was approved by the South Yorkshire Grid Company. The Sheffield Company was under no obligation to take gas, and the United Steel were under no obligation to supply it; it was surplus to the requirements of United Steel.

The price of gas from the grid to the Sheffield Company was 5½d. per 1,000 cu.ft., subject to modification by a coal clause. In fact, the grid price was raised to 5⅝d. in January, 1938, and in July it would be raised to 5¾d. Those prices applied whatever the source of the gas into the grid.

In the Report of the Area Gas Supplies Committee in 1930 it was stated that there were 19 coking plants suitable for connexion to the South Yorkshire grid. Of that number the Company was, in fact, taking supplies from 13, and it was about to take a supply from one other. Some of the others had no supplies or no appreciable supplies available.

In addition to the 19 mentioned in the Report, there were 4 others. One was connected to the Barnsley Gas Undertaking (which had been taken over by the Sheffield Company; the second was giving a supply, and the other 2 had no supplies available. That exhausted the whole of the coke oven gas available in the Company's existing coke oven gas limits.

The whole cost of the grid had been borne by the Sheffield Gas Company. For securing supplies of coke oven gas before the grid was provided, the Company had spent £69,076 on mains. For the gas grid proper the Company had expended £177,000 odd in respect of mains, and £182,293 in respect of land, purifiers, gasholders, &c. The sum of the two latter figures was over £359,000. Two further mains were about to be laid, at a cost of about £17,000.

Between 1917 (when the coke oven gas powers were first obtained) and 1937, the quantities of coal gas made by the Company had decreased from more than 6,000 million cu.ft. to 270 million cu.ft. per annum. The quantities of coke oven gas bought by the Company during the period had increased from nothing to more than 10,000 million cu.ft. per annum. The total amounts of gas sold had increased from 5,700 millions in 1917 to 9,800 millions in 1937; the increase had been steady, and was not due to any temporary cause. The whole of the coke oven gas available from the colliery plants had never been sufficient to meet the whole of the requirements of the Gas Company, and it had never been able to cease the manufacture of gas entirely.

To refute the suggestion that the increased use of gas in the Company's area of supply was due to temporary causes, he said that during the last fortnight representatives of one of the largest firms in Sheffield had informed him that if he could obtain more coke oven gas they could take it; they preferred to use gas rather than solid fuel, and were prepared to use gas if they could be confident of the supplies.

Referring again to the Report of the Area Gas Supply Committee, in which certain South Yorkshire coke ovens and gasworks were mentioned as being in an area suitable for a gas grid, he said that those undertakings were in the area into which the Sheffield Company now proposed to extend its coke oven gas limits.

Dealing with the suggestions by the opponents that the only two coking plants existing in the area now proposed to be added were those at Staveley and Harworth, he said he had been approached on one or two occasions by three coal owners in the area who were likely to erect coke ovens. He had told them that his Company must fulfil its agreement to take first all the gas that was available in the grid; but the time had now come

to extend, and he believed those coal owners would be willing to construct coke ovens if the Gas Company was prepared to take the gas.

There seemed to be a fear on the part of the opponents that the Company would become distributors of purified gas in the area it proposed to add to its coke oven gas limits. He emphasized, therefore, that the Company wanted to secure the gas and to purify it for ultimate use in its area of supply. The Company did not seek exclusive powers in the new area.

As to the suggestion of the Derbyshire Miners' Association, that there was a possibility of a Derbyshire gas grid being constructed, he said it was not a practicable proposition in the area the Company proposed to take over there, but the Company's proposals would not in any way retard the establishment of a Derbyshire grid.

In regard to the area in which the coke oven gas purchase powers of the Company and the Rotherham Corporation overlapped, he said that the present Bill contained nothing which would prevent the Rotherham Corporation making contracts there if they wanted to, and if they could.

Mr. NEEP, dealing with a statement he had made on the previous day, that the Bill contained, perhaps by oversight, a proposal to take away part of the area of the Chesterfield Gas Undertaking, said that in the amended Bill that matter had been adjusted.

Mr. A. M. TRUSTRAM EVE (for the Rotherham Corporation), cross-examining, said that the Sheffield Company had increased its sales of industrial gas enormously since 1932, multiplying almost by three. The Rotherham Corporation had also increased its sales of industrial gas very largely. With a peak demand of 7,050,000 cu.ft. per day last winter, the industrial sales of gas progressing by approximately 20% per annum, and possible contractual supplies available of only 7½ millions per day, the Corporation could be said to be short of gas.

Witness agreed that it would be short, but not so short as the Sheffield Company; Rotherham Corporation were not at the moment making gas, but obtained it all from coke ovens. He wished he were in that position.

Replying to questions as to where Rotherham could secure further supplies in the future, witness said that they could first exhaust their contract with the Sheffield Company, but he could not particularize further sources.

In further cross-examination, Mr. Trustram Eve said that the storage capacity of the Sheffield Company was equivalent to only 75% of its peak day supply. Witness replied that there were many undertakings with less storage capacity, sometimes with only 50%. Counsel's suggestion was that the Sheffield Company allowed the coke oven people to take the place of the the storehouse, or, in other words, allowed the gas to go to waste when the Company did not want it.

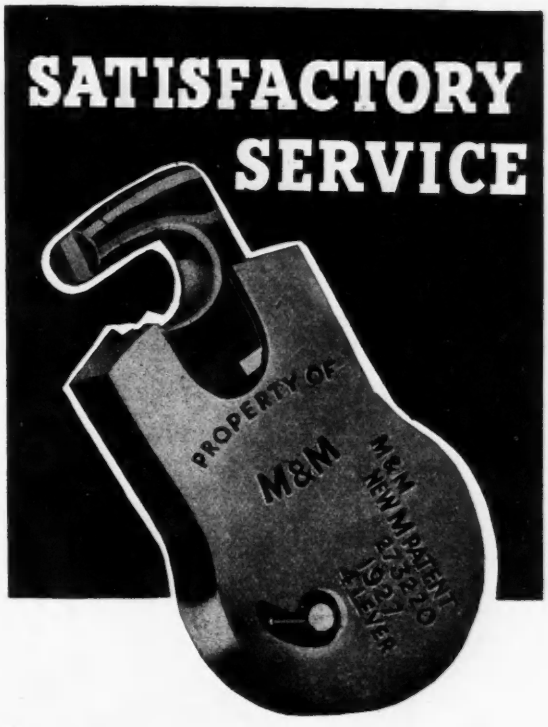
Witness replied that it was impossible for a gas undertaking to provide storage for the week-end.

(To be concluded next week.)

A New Synthetic Lining

As mentioned in the "JOURNAL" for May 4, Messrs. Newton Chambers & Co., Ltd., have introduced into this country "Lithcote," a synthetic lining which has been perfected in America, and which is now being used extensively for the lining of tanks and equipment for the food and other industries where corrosion-resisting and acid-resisting qualities are vitally important. Messrs. Newton Chambers are so impressed with the process that they have become sole British Agents and have the exclusive rights for developing it within the British Isles. "Lithcote" is a type of non-vitreous baking enamel. It is a synthetic lining and coating which can be applied quickly and easily to any metal. It is brush applied or sprayed on and bonded to the prepared surface of any metal by a special baking process, and it gives a hard, smooth, glass-like, non-chipping, flexible, acid-proof, corrosion-proof, solvent-proof, durable, and sterile surface.

Resistance to corrosion and action of chemicals, states a brochure published by the firm, is a feature of "Lithcote" linings—they are inert towards acids, solvents, brines, alcohol, fats, oils, syrups, petroleum, &c., over a wide range of temperature. Ease of cleaning and sterilization is assured by the smooth, glass-like, non-porous surface. Durability is provided by correct balance between hardness and flexibility, ensuring maximum service under all conditions. Adaptability of the special baking process makes installations possible in almost any type of processing, storage, or transportation equipment, without movement from its permanent location or interference with plant operations. "Lithcote" can be applied to any metal. Economy of the lining is apparent in its initial cost, as well as in the reduction of operating, maintenance, and replacement expense. Standardized quality is maintained in every installation by trained operators under expert supervision.



SECURITY & STRENGTH

When you are considering meter locks, remember two things . . . firstly, that the lever type of lock is recognised as the safest type made and is in use on the majority of safes; secondly, that the M & M Patent Meter Lock is the finest of its type on the market. Years of safe service go with every M & M lock sold . . . reducing the cost-per-year figure to the absolute minimum . . . making it the most economical proposition for every type of meter.

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HIGH PRESSURE GASHOLDERS

High Pressure Gasholder 250,000 cubic feet effective capacity 32′ 0″ dia. × 102′ 0″ long, 50 lbs. per square inch working pressure, manufactured and erected for Skipton Urban District Council Gas Department.

The following are some of the advantages of High Pressure Holders:

1. Lower cost of foundations.
2. Less ground space required.
3. Unobtrusive in landscape. Easily hidden by trees.
4. No moving parts.
5. No Liquid seals.
6. Dry Gas.
7. Reduced cost of painting.
8. Less surface exposed to corrosion.
9. Specially useful for District purposes where the provision of High Pressure Holders at advantageous positions tends to smooth out the load curve at the works to a constant demand, enabling regularity of working to be maintained at the works. Smaller mains are required than with Low Pressure Holders, with reduced cost of mains and mainlaying.

SEND YOUR ENQUIRIES TO:

NEWTON CHAMBERS THORNCLIFFE & CO. LTD.

Nr. SHEFFIELD

Dickson

Markets and Manufactures

Current Sales of Gas Products

The London Market

May 23.

There is little of interest to report in the prices of Tar Products in the London market, which remain as follows:

Pitch nominal at about 33s. per ton f.o.b.
Creosote, about 5½d.
Refined tar, 3¼d.
Pure toluole, 2s. 1d. to 2s. 2d.
Pure benzole, about 1s. 9d.
95/160 solvent naphtha, 1s. 7d.
90/160 pyridine, 10s. to 11s.
All per gallon naked at makers' works.

The Provinces

May 21.

Crude Gas-Works Tar, 19s. to 24s.

To avoid misunderstanding, it is necessary to state that the above price is not claimed to represent a market value. It is a price worked out from week to week upon a system which has been used for many years as a basis for the fixing of certain contracts for crude tar of varying qualities in different areas.

The average prices of gas-works products during the week were: Pitch—East Coast, 33s. to 34s. f.o.b. West Coast—Manchester, Liverpool, Clyde, 33s. to 34s.* Toluole, naked, North, 1s. 7½d. to 1s. 9d. Coal tar, crude naphtha, in bulk, North, 7¾d. to 8¼d. Solvent naphtha, naked, North, 1s. 4½d. to 1s. 5d. Heavy naphtha, North, 1s. 3d. to 1s. 3¼d. Creosote, *ex* works, in bulk, North, liquid and salty, 4¾d. to 5¼d.; low gravity, 4¼d. to 4¾d. Heavy oils, in bulk, North, 5d. to 5¼d. Carbolic acid 60's, 2s. 3d. to 2s. 6d. Naphthalene, £13 10s. to £16. Salts, 80s. to 85s., bags included. Anthracene, "A" quality, 4½d. to 4¾d. per minimum 40% purely nominal; "B" quality unsalable.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls whatever they may be.

Scotland

GLASGOW, *May* 21.

There is still little sign of reviving interest in the various Tar Products, and prices continue unstable.

Crude gas-works tar.—Actual value is 37s. to 38s. per ton *ex* works in bulk.

Pitch is practically without interest at round 26s. to 27s. per ton f.o.b. Glasgow for export, and about 25s. to 26s. per ton *ex* works in bulk for home trade.

Refined tar.—Demand is fairly substantial in the home market at fixed price of 3¼d. to 4d. per gallon f.o.r. naked, but export is not too brisk with value unchanged at 3d. to 3¼d. per gallon in buyers' packages at makers' works.

Creosote oil is well looked after locally with prices maintained as follows: Specification oil, 5d. to 5¼d. per gallon; low gravity, 6¼d. to 6¼d. per gallon; neutral oil, 5d. to 5¼d. per gallon; all *ex* works in bulk.

Cresylic acid.—There is still very little buying interest, and prices are irregular. The following can be taken as being about average: Pale, 97/99%, 2s. to 2s. 3d. per gallon; dark, 97/99%, 1s. 9d. to 2s. per gallon; and pale, 99/100%, 2s. 6d. to 2s. 8d. per gallon; all according to quality *ex* works in buyers' packages.

Crude naphtha is not too brisk at 5¼d. to 6d. per gallon *ex* works in bulk, according to quality.

Solvent naphtha is comparatively quiet, with 90/160 grade unchanged at 1s. 4d. to 1s. 4½d. per gallon, and 90/190 heavy naphtha at 1s. 1d. to 1s. 1½d. per gallon.

Motor benzole commands 1s. 4d. to 1s. 4½d. per gallon.

Pyridine.—Business is slow, but, production being small, prices are unchanged at 10s. 6d. to 11s. per gallon for 90/160 grade and 11s. to 12s. per gallon for 90/140 grade.

Benzole Prices

These are considered to be the market prices for benzole at the present time:

	s. d.	s. d.	
Crude benzole..	0 9½	to 0 10	per gall. at works
Motor „ ...	1 3	„ 1 3½	„ „ „
90% „ ..	1 4	„ 1 4½	„ „ „
Pure „ ..	1 8	„ 1 8½	„ „ „

Contracts Advertised To-Day

Coal.
Droitwich Gas Department. [p. 633.]
Skipton Gas Department. [p. 633.]

Gasholder Painting.
Lincoln Gas Department. [p. 634.]

Gasholder Repairs.
Hindley Gas Department. [p. 634.]

Goods Hoist.
Skipton Gas Department. [p. 633.]

Mainlaying.
Teignmouth Gas Department. [p. 633.]

Mains, Pipes, Specials, &c.
Rochdale Gas Department. [p. 633.]
Teignmouth Gas Department. [p. 633.]

Mantles.
Sutton-in-Ashfield Gas Department [p. 633.]

Meters.
Sutton-in-Ashfield Gas Department [p. 633.]

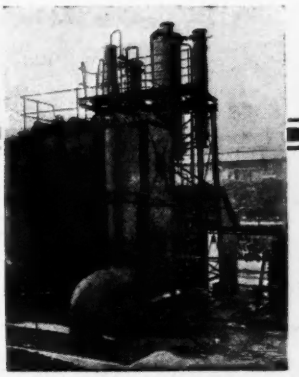
Steam Tubes and Fittings.
Dewsbury Gas Department. [p. 634.]
Sutton-in-Ashfield Gas Department [p. 633.]

Northampton's New Issue

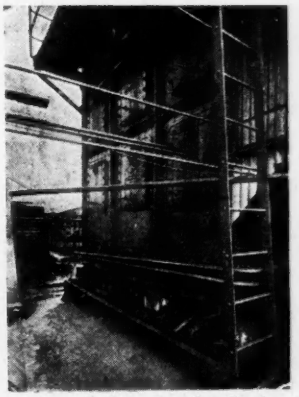
The lists of applications for £48,984 consolidated stock of the Northampton Gaslight Company, referred to in last week's "JOURNAL," were closed in half-an-hour. Entitled to a maximum dividend of 5% per annum and offered at £110 per £100, yielding at that price £4 10s. 11d. per annum, the issue was heavily over-subscribed.

Colonial Gas Association Issue

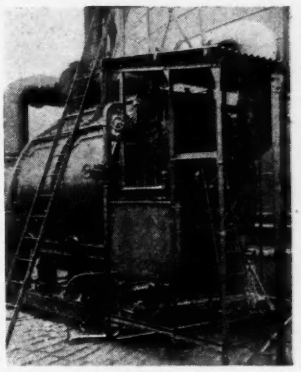
An issue of 75,021 8% preference shares of £1 each at 23s. per share in English currency and 28s. 9d. per share in Australian currency is announced by the Directors of the Colonial Gas Association. The shares offered carry a non-cumulative preferential dividend of 8% per annum (Australian currency) and rank, as regards repayment of capital, in priority to the ordinary shares. When fully paid up these shares will rank in all respects *pari passu* with the existing preference shares of the Company. The issue has been rendered necessary by the continued expansion of the Association and its Subsidiary Companies.



"Permac" Joints in a Gas Works.



"Permac" Joints in a Gas Works.



"Permac" Joints in a Gas Works.

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METAL-TO-METAL JOINTING MATERIAL

Ever since 1913 "PERMAC," the original Metal-to-Metal Jointing, has been holding up difficult joints like these in Important Gas Works and on Coke Oven Plants all over the world. Equally suitable for any joint—steam, water, gas, oil—screw pipe or flange. Send for particulars.

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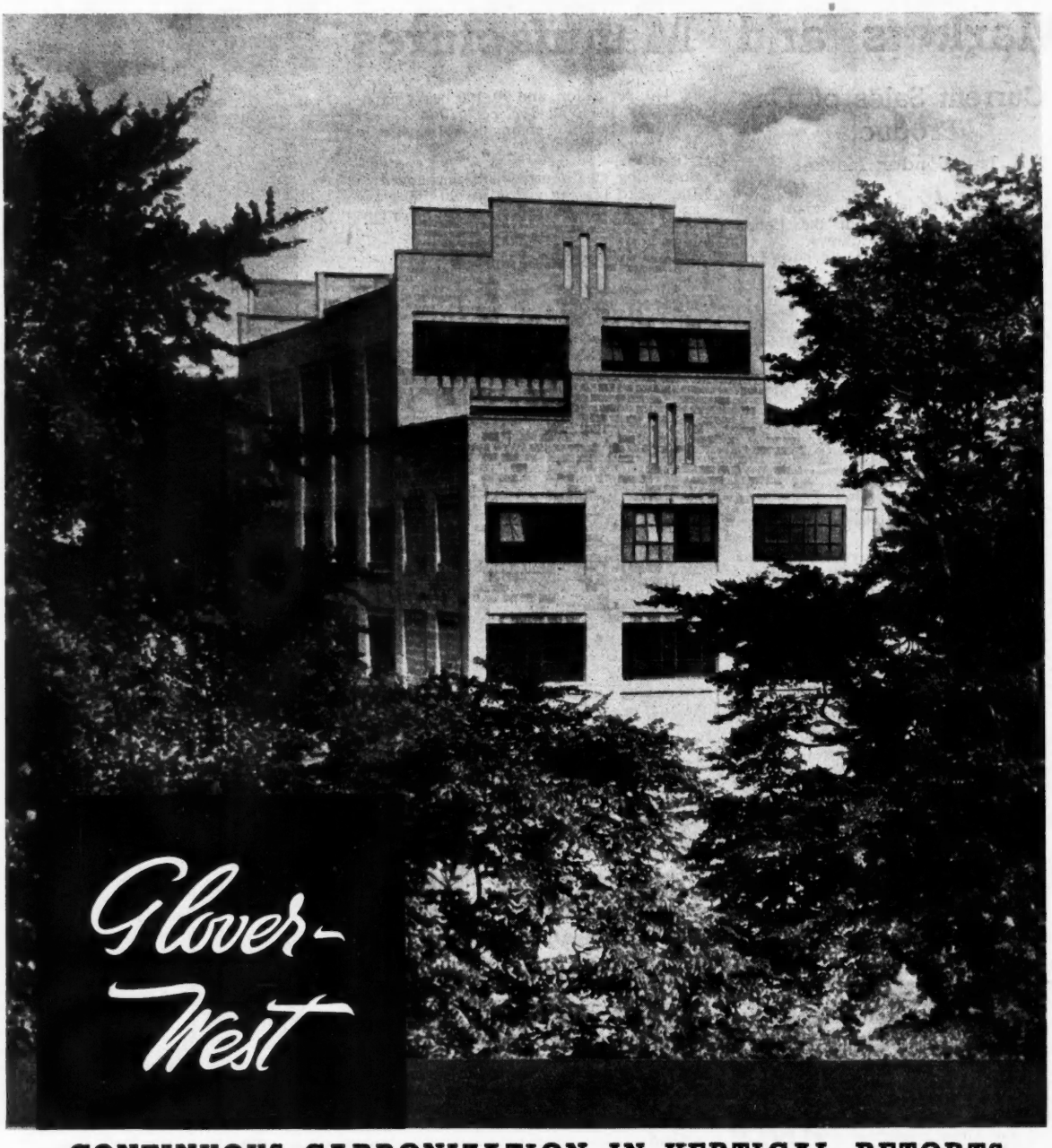

CONTINUOUS CARBONIZATION IN VERTICAL RETORTS

The illustration shows the Glover-West vertical retort house and coke grading plant built for the Buxton Corporation Gas Department, of typical modern exterior design.

421 plants
built or in construction in
24 countries

WEST'S GAS IMPROVEMENT CO. LTD.,
MANCHESTER: Albion Ironworks, Miles Platting ■ LONDON: Columbia House, Aldwych, W.C.2

GAS STOCKS AND SHARES

The only feature relieving the general dullness of markets last week was a sudden activity in low-priced gold shares. Elsewhere the volume of business remained small. The success of the Kent issue, following the failure of the L.C.C. Loan, had a steadying influence on the gilt-edged market which closed firm. The heavy decline in the value of home rails eased up, but industrials were idle with prices mostly on the down grade. The Shell and Royal Dutch dividend announcements being in accordance with market expectations had little effect on oil prices, while rubbers were easier on the lower price of the commodity. Hardly a week passes nowadays without some European political crisis arising which prohibits the return to anything approaching normal conditions, and current events indicate that the present week will be no exception to the general rule.

The daily lists of recorded transactions in the Gas market show that despite the dull conditions the section was well supported, and prices with few exceptions closed unaltered. In the Official List the only changes of note included a drop of 3d. in Gas Light units and a fall of 1s. in South-Western ordinary shares. On the Liverpool Exchange Chester hardened 3 points to 107-110, business being recorded at 109, and Liverpool ordinary closed ⅜ higher at 124⅜-125½. Apart from a rise of 2 in Rugby 6% preference, nominal quotations in the Supplementary List were unchanged.

The accounts of Associated Gas and Water Undertakings for the year to March 31 show a net revenue balance of £59,419 against £37,621. Investments in subsidiaries during the year increased from £2,145,127 to £2,358,680, and in the same period majority interests have been acquired in the Barnstaple, Burgess Hill, and Ilfracombe Gas Companies. The Directors are recommending a final dividend of 2½%, again making 5% for the year, and after providing for this and the preference dividends the carry-forward is raised from £10,271 to £17,564. The £1 shares are obtainable at round about 19s. to yield £5 5s. 3d.%.

Official Quotations on the London Stock Exchange

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations May 20.	Rise or Fall on Week.
1,767,439	Mar. 7	8	8	Alliance & Dublin Ord. ...	140—150	...
374,000	Dec. 13	4	4	Do. 4 p.c. Deb. ...	95—100	...
558,190	May 9	5	5	Assed. Gas & Water U'd'cts Ord.	17/6—19/6*	...
500,000	,,	4¼	4¼	Do. 4¼ p.c. Red. Cum. Pref.	19/—21/-*	...
216,041	,,	§-/4	4	Do. 4 p.c. Red. Cum. Pref.	19/—20/-*	...
278,590	,,	4	4	Do. 4 p.c. Irred. Cum. Pref.	17/—19/-*	...
500,000	Mar. 7	3½	3½	Do. 3½ p.c. Red. Deb. ...	94—99	...
558,890	Feb. 21	7	7	Barnet Ord. 7 p.c.	158—163	...
300,000	Apl. 4	1/4½	1/9¾	Bombay, Ltd.	24/6—26/6	...
179,915	Feb. 21	9½	9½	Bournemouth sliding scale ...	195—205	...
590,407	,,	7	7	Do. 7 p.c. max. ...	157—162	...
493,960	,,	6	6	Do. 6 p.c. Pref. ...	132—137	...
50,000	Dec. 13	3	3	Do. 3 p.c. Deb. ...	78—83	...
262,025	,,	4	4	Do. 4 p.c. Deb. ...	98—103	...
335,000	,,	5	5	Do. 5 p.c. Deb. ...	115—120	...
357,900	Feb. 21	7½	7½	Brighton, &c., 6 p.c. Con. ...	145—150	...
649,955	,,	6¾	6¾	Do. 5 p.c. Con. ...	128—133	...
205,500	,,	6	6	Do. 6 p.c. 'B' Pref.	125—130	...
855,000	Mar. 7	7	8	British Ord.	138—143	...
100,000	Dec. 13	7	7	Do. 7 p.c. Pref.	142—147	...
350,000	,,	5½	5½	Do. 5½ p.c. 'B' Cum. Pref.	110—115	...
120,000	,,	4	4	Do. 4 p.c. Red. Deb. ...	95—100	...
450,000	,,	5	5	Do. 5 p.c. Red. Deb. ...	102—107	...
450,000	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	95—100	...
100,000	22 May'33	6	4	Cape Town, Ltd.	1½—2½	...
100,000	6 Nov.'33	4½	4½	Do. 4½ p.c. Pref. ...	1½—3½	...
150,000	Dec. 13	4½	4½	Do. 4½ p.c. Deb. ...	65—75	...
626,860	Feb. 7	6	6	Cardiff Con. Ord.	120—125	...
237,860	Dec. 13	5	5	Do. 5 p.c. Red. Deb.	106—111	...
98,936	Mar. 21	2/-	2/-	Colombo Ord....	1¾—1¾	...
24,510	,,	1/4½	1/4½	Do. 7 p.c. Pref.	23/—25/-	...
739,453	Mar. 21	-/11·48	-/11·48	Colonial Gas Assn. Ltd. Ord.	16/6—18/6	...
296,144	,,	1/3·30	1/3·30	Do. 8 p.c. Pref.	23/—25/-	...
1,775,005	Feb. 7	5	5	Commercial Ord.	83—88	...
620,000	Nov. 29	3	3	Do. 3 p.c. Deb. ...	73—78	...
286,344	Feb. 7	5	5	Do. 5 p.c. Deb. ...	113—118	...
807,560	Feb. 21	7	7	Croydon sliding scale... ...	137—142	...
644,590	,,	5	5	Do max. div.	107—112	...
620,385	Dec. 13	5	5	Do. 5 p.c. Deb.	115—120	...
239,000	Feb. 7	5	5	East Hull Ord. 5 p.c.... ...	96—101	...
185,355	Feb. 21	6	6	East Surrey Ord. 5 p.c. ...	118—123	...
176,211	Dec. 13	5	5	Do. 5 p.c. Deb. ...	115—120	...
250,000	Nov. 15	7	4	Gas Consolidation Ord. ...	19/—21/-	...
250,000	May 9	4	4	Do. 4 p.c. Red. Cum. Pref.	17/6—19/6*	...
19,223,324	Feb. 7	5⅜	5⅜	Gas Light & Coke Ord. ...	23/—24/-*a*	—/3
2,600,000	,,	3½	3½	Do. 3½ p.c. max. ...	78—81	...
4,477,106	,,	4	4	Do. 4 p.c. Con. Pref.	99—102	...
2,993,000	Jan. 17	...	3½	Do. 3½ p.c. Red. Pref.	100½—102½	...
8,602,497	Nov. 29	3	3	Do. 3 p.c. Con. Deb.	78—81	...
3,642,770	,,	5	5	Do. 5 p.c. Red. Deb.	112—115	...
3,500,000	,,	4½	4½	Do. 4½ p.c. Red. Deb.	110—113	...
700,000	Mar. 7	3½	3½	Do. 3½ p.c. Red. Deb.	97—100	...
270,466	Feb. 21	6	6	Harrogate New Cons. ...	118—123	...
157,500	Mar. 21	1/2⅝	1/‡	Hong Kong and China Ord	¾—1	...
213,200	Feb. 7	6	6	Hornsey Con. 3½ p.c. ...	100—110	...
5,600,000	May 9	8	12	Imperial Continental Cap. ...	125—130	—2
223,130	Jan. 17	3½	3½	Do. 3½ p.c. Red. Deb. ...	88—93	...
285,242	Feb. 21	8½	8½	Lea Bridge 5 p.c. Ord. ...	167—172	...
11,751	Feb. 21	8	10	Maidstone 5 p.c. Cap.... ...	175—185	...
63,480	Dec. 13	3	3	Do. 3 p.c. Deb. ...	70—75	...
75,000	Nov. 29	†10	†10	Malta & Mediterranean ...	142—147	...
392,000	Apl. 1	5½	5½	Metropolitan (of Melbourne) 5½ p.c. Red. Deb.	99—102	...

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations May 20.	Rise or Fall on Week.
231,977	Feb. 21	5	5	M.S. Utility 'C' Cons. ...	99—104	...
968,658	,,	4	4	Do. 4 p.c. Cons. Pref.	95—100	...
360,075	Dec. 13	4	4	M.S. Utility 4 p.c. Deb. ...	97—102	...
148,955	,,	5	5	Do. 5 p.c. Deb. ...	113—118	...
675,000	May 9	†6	†6	Montevideo, Ltd.	70—75*	...
250,000	Mar. 7	7½	7½	North Middlesex 6 p.c. Con.	145—150	...
396,160	Feb. 7	5	5	Northampton 5 p.c. max. ...	107—112	...
300,000	Apl. 25	†9	†7	Oriental, Ltd.	150—155	...
468,537	Dec. 13	8	8	Plymouth & Stonehouse 5 p.c.	154—159	...
621,667	Feb. 7	8½	8½	Portsmouth & Gosport Cons.	160—165	...
241,446	,,	5	5	Do. 5 p.c. max. ...	102—107	...
73,350	,,	5	5	Do. 5 p.c. Pref. ...	108—113	...
247,966	Dec. 13	4	4	Primitiva 4 p.c. Cons. Deb. ...	98—103	...
625,959	Jan. 17	4	4	Do. 4 p.c. Red. Deb. ...	95—100	...
15,000	Mar. 21	6	6	San Paulo 6 p.c. Cum. Pref. ...	8¾—9½	...
441,275	Apl. 25	1/1½	1/1½	Severn Val. Gas Cor. Ld. Ord.	20/6—22/6	...
460,810	Mar. 21	-/10½	-/10½	,, ,, 4½ p.c. Cum. Pref.	19/6—21/6	...
133,201	Feb. 7	8½	5	Shrewsbury 5 p.c. Ord. ...	128—133	...
9,000	June 7	4	4	South African Ord.	3¾—4¾	...
1,371,752	Apl. 25	1/2⅜	1/2⅜	South East'n Gas Cn. Ld. Ord.	21/6—23/6	...
871,636	Mar. 7	-/10⅝	-/10⅝	Do. 4½ p.c. Red. Cum. Pref.	20/6—22/6	...
498,818	,,	4	4	Do. 4 p.c. Cum. Pref. ...	18/—20/-	...
450,000	Feb. 7	4	4	Do. 4 p.c. Deb.	100—103	...
150,000	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	95—98	...
6,709,895	Feb. 7	6	5	South Met. Ord.	104—107	...
1,135,812	,,	6	6	Do. 6 p.c. Irred. Pf. ...	130—135	...
850,000	,,	4	4	Do. 4 p.c.Irred. Pf. ...	97—100	...
1,895,445	Dec. 13	3	3	Do. 3 p.c. Deb. ...	78½—81½	...
1,000,000	Jan. 17	5	5	Do. 5 p.c. Red. Deb....	109—112	...
1,543,795	Feb. 7	6	6	South Suburban Ord. 5 p.c. ...	118—123	...
512,825	,,	5	5	Do. 5 p.c. Pref....	110—115	...
500,000	,,	4	4	Do. 4 p.c. Pref....	95—100	...
250,000	,,	§18/9	3¾	Do. 3¾ p.c. Red. Pref.	98—101	...
888,587	Dec. 13	5	5	Do. 5 p.c. Deb....	115—120	...
250,000	,,	4	4	Do. 4 p.c. Deb....	97—100	...
200,000	Sept. 20	...	3½	Do. 3½ p.c. Red. Deb.	94—99	...
427,859	Apl. 25	1/2⅜	9½	S. Western Gas & Water Ord.	16/6—18/6	—1/-
160,523	,,	-/10½	-/10½	Do. 4½ p.c. Red. Cum. Pf.	19/—21/-	...
110,000	Dec. 13	4	4	Do. 4 p.c. Red. Deb. ...	97—102	...
750,541	Feb. 7	5	5½	Southampton Ord. 5 p.c. ...	109—114	...
148,836	Dec. 13	4	4	Do. 4 p.c. Deb.	96—101	...
350,000	Feb. 7	5½	5½	Swansea 5½ p.c. Red. Pref. ...	108—113	...
94,000	Jan. 3	3½	3½	Do. 3½ p.c. Red. Deb. ...	95—100	...
1,076,490	Feb. 7	6½	6½	Tottenham and District Ord.	126—131	...
409,835	,,	5½	5½	Do. 5½ p.c. Pref....	119—124	...
62,235	,,	5	5	Do. 5 p.c. Pref....	108—113	...
371,850	Dec. 13	4	4	Do. 4 p.c. Deb....	97—102	...
85,701	Apl. 25	6	6	Tuscan 6 p.c. Red. Deb. ...	95—100	...
888,629	Apl. 4	4	6	U. Kingdom Gas Cor. Ord....	18/6—20/6	...
937,743	May 9	4½	4½	Do. 4½ p.c. 1st Cum. Pref.	19/6—21/6*	...
500,000	,,	-/1·15	4	Do. 4 p.c. 1st Red. Cum. Pf.	19/—21/-*	...
745,263	Dec. 13	4½	4½	Do. 4½ p.c. 2nd Non-Cum.Pf.	16/6—18/6	...
1,000,000	Mar. 7	3½	3½	Do. 3½ p.c. Red. Deb. ...	96—99	...
373,939	Feb. 7	7	7	Uxbridge, &c., 5 p.c.	133—138	...
133,010	,,	5	5	Do. 5 p.c. Pref. ...	108—113	...
1,371,138	Feb. 7	7	7	Wandsworth Consolidated ...	137—142	...
2,525,768	,,	4	4	Do. 4 p.c. Pref. ...	98—101	+1
1,343,964	Dec. 13	5	5	Do. 5 p.c. Deb. ...	116—121	...
383,745	,,	4	4	Do. 4 p.c. Deb. ...	98—103	...
558,342	Feb. 7	7	7	Watford and St. Albans Ord.	135—140	...
200,000	,	5	5	Do. 5 p.c. Pref. ...	110—115	...
200,000	,,	5½	5½	Do. 5½ p.c Pref. ...	120—125	...
200,000	Nov. 29	4	4	Do. 4 p.c. Red. Deb.	97—102	...
100,000	,,	3½	3½	Do. 3½ p.c. Red. Deb.	95—100	...

a.—The quotation is per £1 of stock. * Ex. div. † Paid free of income-tax ‡ For year. § Actual.

Supplementary List and Provincial Exchanges overleaf.

STOCK AND SHARE LIST—Cont.

Supplementary List; not Officially Quoted, London

Issue £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations May 20.	Rise or Fall on Week.
202,152	Mar. 21	5	5	Ascot Ord.	103—108	...
128,182	Dec. 13	5	5	Do. 5 p.c. Pref.	108—113	...
31,035	Mar. 21	...	-/4½	Associated Utilities 4 p.c. Pref.	16/—18/-	...
100,000	Dec. 13	...	3½	Do. 3½ p.c. Red. Deb....	95—100	...
17,000	Feb. 21	8	8	Bognor Orig. Ord. 'A' ...	155—165	...
62,210	,,	8	8	Do. New Addl. 'A' ...	155—165	...
87,160	,,	7	7	Do. New 7 p.c. max.	152—157	...
37,440	Feb. 7	10	10	Cam. Univ. & Town10 p.c. max.	190—200	...
125,970	,,	7	7	Do. 7 p.c. max.	135—140	...
39,025	,,	5	5	Do. 5 p.c. max.	97—102	...
96,410	Feb. 7	4½	4½	Cardiff 4½ p.c. Pref. ...	95—100	...
150,000	Feb. 21	4	4	Croydon 4 p.c. Pref. ...	95—100	...
130,000	Dec. 13	4	4	Do. 4 p.c. Deb. ...	97—102	...
65,000	Mar. 7	7½	8½	Eastbourne 'A' 5 p.c.	155—160	...
198,000	,,	6	7	Do. 'B' 3½ p.c. ...	125—130	...
112,312	,,	5	5	Do. 5 p.c. Pref. ...	107—112	...
130,000	Dec. 13	5	5	Do. 5 p.c. Deb. ...	113—118	...
24,000	Feb. 21	8½	8½	Great Yarmouth 8½ p.c. max.	43—48	...
59,400	,,	7½	7½	Do. 7½ p.c. max. ...	33—38	...
51,160	Dec. 13	5½	5½	Do. 5½ p.c. Deb. ...	125—130	...
152,600	Feb. 21	8	9	Guildford Cons. ...	167—172	...
54,055	,,	5	5	Do. 5 p.c. Pref. ...	108—113	...
68,250	Dec. 13	5	5	Do. 5 p.c. Deb. ...	112—117	...
156,600	Feb. 21	7½	7½	Hampton Court Cons. ...	140—150	...
80,000	Feb. 21	4	4	Lea Bridge 4 p.c. Pref ...	94—99	...
60,000	,,	6	6	Do. 6 p.c. Pref. ...	123—128	...
94,876	Dec. 13	4	4	Do. 4 p.c. Deb. ...	97—100	...
73,620	Mar. 7	8½	8½	Luton Cons. 'A'	160—165	...
107,960	Mar. 21	4	5½	Mid Kent Ord.	8½—9½	...
230,940	Feb. 7	10	10	Oxford & District Ord. ...	198—203	...
47,112	,,	5	5	Do. 5 p.c. Pref.	106—111	...
50,000	,,	6	6	Do. 6 p.c. Red. Pref. ...	108—113	...
126,193	May 9	7½	7½	Peterborough Ord.	135—145*	...
64,990	Mar. 7	6½	7½	Redditch Ord....	120—130	...
166,850	Feb. 7	8	8	Romford Ord....	148—153	...
60,000	,,	4	4	Do. 4 p.c. Pref.	97—100	...
44,000	Mar. 21	5	5	Do. 5 p.c. Deb.	111—116	...
25 570	Feb. 7	5½	5½	Rugby 5½ p.c. Pref.	123—128	...
25,000	,,	6	6	Do. 6 p.c. Red. Pref ...	105—110	+2
42,750	Dec. 13	5½	5½	Do. 5½ p.c. Deb.	120—125	...
110,950	Feb. 21	8	8	Ryde Ord.	140—150	...
270,086	Mar. 21	7	7	Slough Ord.	128—133	...
21,000	Dec. 13	5	5	Do. 5 p.c. Deb.	110—115	...
28,872	May 9	5½	5½	S. Midland Gas Cpn. Ltd. Ord.	19/—21/-*	...
28,866	Mar. 7	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	18/6—20/6	...
137,730	Feb. 21	7	7	Southgate & Dist. 7 p.c. max.	135—140	...
62,500	,,	5	5	Do. 5 p.c. Pref.	110—115	...
117,228	Feb. 7	5	7	Swindon Cons.	104—109	...
60,425	Dec. 13	5	5	Do. 5 p.c. Deb.	110—115	...
64,380	Dec. 13	5	5	Torquay and Paignton 5 p.c. Pf.	108—113	...
33,858	May 9	-/2·70b	4½	United Kingdom Gas Corpn. 4½ p.c. 1st Cum. Pref. ...	18/—20/-*	...
130,000	Feb. 7	5	8	Wakefield Ord.	118—123	...
81,650	,,	5	5	Do. 5 p.c. max.	101—106	...
82,000	Feb. 21	6	6	Weymouth Ord.	105—110	...
98,384	Feb. 7	6	6	Wolverhampton 6 p.c. Pref....	118—123	...
160,000	Dec. 13	5½	5½	Do. 5½ p.c. Rd. Db.	107—112	...
90,000	Dec. 13	5	5	York 5 p.c. Red. Deb.... ...	104—109	...
133,640	Feb. 21	6½	6½	Yorktown (Cam.) 5 p.c. Cons.	120—125	...
120,000	,,	5	5	Do. 5 p.c. Pref.	106—111	...
35,000	Dec. 13	5½	5½	Do. 5½ p.c. Deb.	121—126	...

BRISTOL EXCHANGE

Issue	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations, May 20.	Rise or Fall on Week
347,756	Feb. 7	5	6	Bath Cons.	120—122	...
1,667,250	Feb. 7	5	5	Bristol, 5 p.c. max.	115—117	...
120,420	Dec. 13	4	4	Do. 1st 4 p.c. Deb. ...	100—102	...
217,870	,,	4	4	Do. 2nd 4 p.c. Deb. ...	100—102	...
328,790	,,	5	5	Do. 5 p.c. Deb.	119—122	...
274,000	Feb. 21	5	5	Newport (Mon.) 5 p.c. max....	99—101	...
13,200	Mar. 21	7	8⅝	Pontyp'l Gas & W. 10 p.c. 'A'	12½—13½	...
13,600	,,	5	6	Do. 7 p.c. 'B'	11½—12½	...
40,000	,,	5	6	Do. 7 p.c. 'C'	11½—12½	...
140,778	Feb. 7	5	5	Weston-super-Mare Cons. ...	110—112	...
64,338	Jan. 3	4	4	Do. 4 p.c. Deb.	94½—96½	...
33,340	,,	7½	7½	Do. 7½ p.c. Deb.	154—157	...

LIVERPOOL EXCHANGE

Issue	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations, May 20.	Rise or Fall on Week
157,150	Feb. 7	5	6½	Chester 5 p.c. Ord.	107—110	+3
92,500	Dec. 13	4	4	Do. 4 p.c. Pref.	96—100	...
36,430	,,	3½	3½	Do. 3½ p.c. Deb.	88—91	...
41,890	,,	4	4	Do. 4 p.c. Red. Deb. ...	97—101	...
2,167,410	Feb. 21	6	6	Liverpool 5 p.c. Ord.... ...	124¼—125¼	+¾
245,500	Dec. 13	5	5	Do. 5 p.c. Red. Pref. ...	99—104	...
306,083	Jan. 17	4	4	Do. 4 p.c. Deb. ...	100—102	...
106,280	Feb. 7	10	10	Preston 'A' 10 p.c.	202—212	...
188,219	,,	7	7	Do. 'B' 7 p.c.	144—154	...

NEWCASTLE EXCHANGE

Issue	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations, May 20.	Rise or Fall on Week
122,577	Feb. 21	8	8	Blyth 5 p.c. Ord.	163½—164½	...
732,000	Feb. 21	5	5	Hartlepool G. & W. Cn. & New	110—112	...
2,061,315	Feb. 7	5	5½	Newcastle & Gateshead Con.	22/9—23/3a	...
682,856	,,	4	4	Do. 4 p.c. Pref. ...	99½—100½	...
776,706	Jan. 3	3½	3½	Do. 3½ p.c. Deb. ...	90—91	...
277,285	May 9	5	5	Do. 5 p.c. Deb. '43...	103—105	...
332,351	Feb. 7	6	6	Sunderland 6 p.c. max. ...	137—139	...

NOTTINGHAM EXCHANGE

Issue	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations May 20.	Rise or Fall on Week
542,270	Feb. 21	6	9	Derby Con.	135—140	...
55,000	Dec. 13	4	4	Do. 4 p.c. Deb.	100—105	...
20,000	Dec. 13	5	5	Long Eaton 5 p.c. Pref. ...	10—12	...
80,000	,,	5	5	Do. 5 p.c. Deb. ...	105—110	...

SHEFFIELD EXCHANGE

Issue	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations May 20.	Rise or Fall on Week
10,000	Feb. 21	10	10	Great Grimsby 'A' Ord. ...	205—215	...
6,500	,,	10	10	Do. 'B' Ord. ...	205—215	...
79,000	,,	10	10	Do. 'C' Ord. ...	195—205	...
1,806,339	Feb. 21	6½	6½	Sheffield Cons.	139—142	...
95,000	Jan. 3	4	4	Do. 4 p.c. Deb.	102—104	...

a The quotation is per £1 of Stock. b Actual. * Ex div.

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